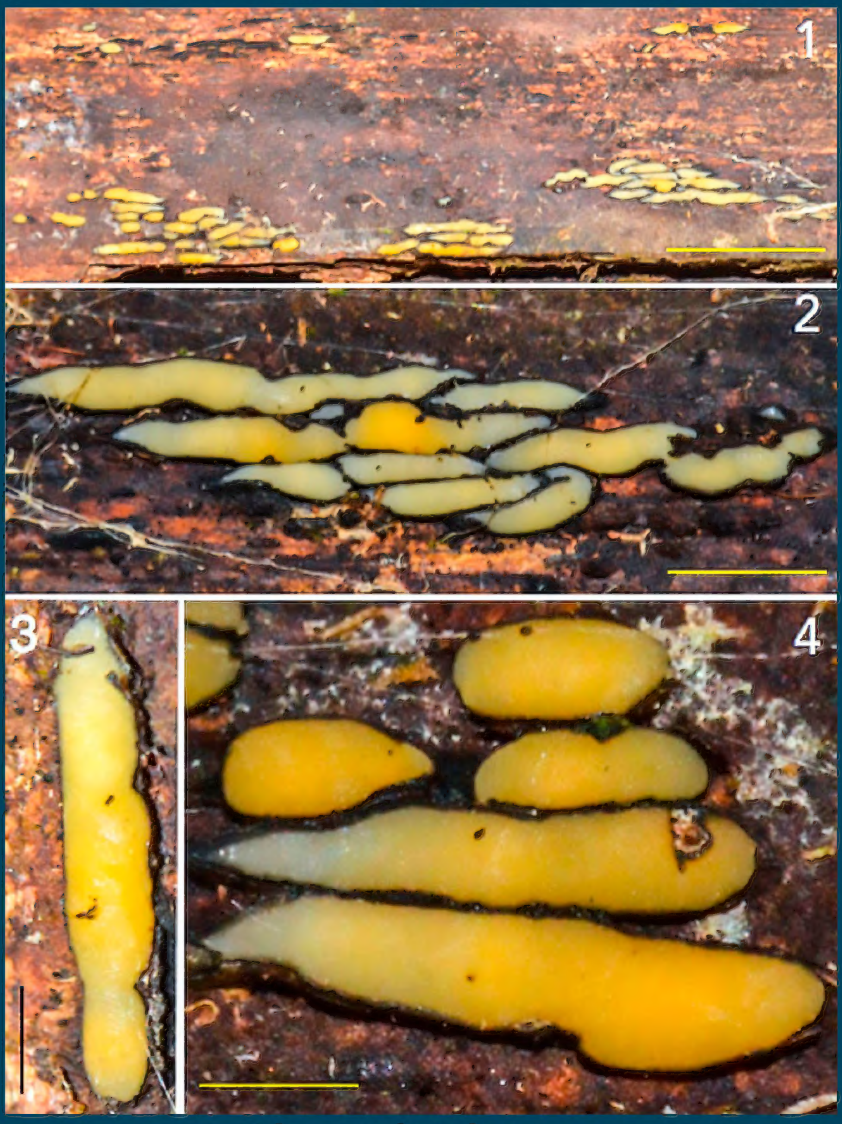
MYCOTAXON

THE INTERNATIONAL JOURNAL OF FUNGAL TAXONOMY & NOMENCLATURE

VOLUME 132 (4) OCTOBER–DECEMBER 2017



Colpoma guadueticola sp. nov.
(Raymundo, Soto-Agudelo & Valenzuela—FIGS 5–11, p. 823)

ISSN (PRINT) 0093-4666 https://doi.org/10.5248/132-4 ISSN (ONLINE) 2154-8889
MYXNAE 132(4): 707–1001 (2017)

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ISSN 0093-4666 (print)
ISSN 2154-8889 (online)

MYCOTAXON

THE INTERNATIONAL JOURNAL OF FUNGAL TAXONOMY & NOMENCLATURE

OCTOBER–DECEMBER 2017

VOLUME 132 (4)

http://dx.doi.org/10.5248/132-4

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MYCOTAXON

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publication date for volume one hundred thirty-two (3)

Mycotaxon *for* July–September 2017, (i–xiv + 471–706)
was issued on October 2, 2017

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[MB 813055], p. 728
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Reviewers — volume one hundred thirty-two (4)

The Editors express their appreciation to the following individuals who have, prior to acceptance for publication, reviewed one or more of the papers prepared for this quarter.

Najam ul Sehar Afshan
André Aptroot
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Eugene Yurchenko
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Xiu-Guo Zhang
Huan-Di Zheng

Errata from previous volumes

Volume 122

pp. 449–460 FOR: *Arthrinium rasikravindrii* or *A. rasikravindrii*
READ: *Arthrinium rasikravindrae* or *A. rasikravindrae*

The paper "*Arthrinium rasikravindrii* [sic] sp. nov. from Svalbard, Norway" by Singh et al. proposed a new species honoring Dr. Rasik Ravindra. Although the director of the National Centre for Antarctic & Ocean Research and leader of the first Indian Arctic Expedition is a man (as indicated by the masculine genitive ending –ii on the published species epithet), the International Code of Nomenclature for algae, fungi, and plants requires the feminine genitive ending –ae for any name ending in –a, regardless of the gender of the person (Rec. 60C.1(a)).

The misspelled species epithet should be corrected to '*rasikravindrae*' throughout. The misspelling appears on p. 449 lines 5, 13, 19; in running titles on pp. 451, 453, 455, 457, 459; on p. 451 line 5; p. 452 line 13; p. 453 Fig. 1 legend, line 1; p. 454 lines 31, 33, 36 and Fig. 2 legend, line 2; p. 456, Phylotree (Fig. 3): top 7 branches; Fig. 3 legend, line 2; primary text line 5; p. 457 Phylotree (Fig. 4): branches 22–28; p. 458 lines 2, 7, 9, 10, 12, 14, 17 & 18.

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p. 589 line 3 ADD: Mycotaxon, Ltd. is thanked for underwriting the publication costs for this manuscript.

Back cover, line 1
FOR: *Cephalotrichum tuffiforme* READ: *Cephalotrichum turriforme*

From the Editor-in-Chief

Materials & methods—removing the tedium. Mycologists and other scientists are usually introduced to materials and methods while writing lab reports, dissertations, or grant applications—situations in which devotion to minute detail is encouraged or where a budget must be calculated. When publishing short papers, however, the 'M&M' section is best kept brisk, pertinent, and succinct. Only procedures producing results should be included. Although researchers may have spent many, many exasperating hours extracting, amplifying, and sequencing DNA, no one wishes to read about the process unless phylogenetic results appear later in the paper.

Likewise, if the procedures followed are the same found in a previous publication, do not invent text or copy from the older paper; simply insert a text reference, such as "ITS rDNA was extracted and amplified according to White & al. (1990)." Once. Extra (brief) detail is needed only when the referenced protocol has been modified.

Easy worldwide access to today's Internet means that Mycotaxon readers are no longer heart-warmed by recitation of company, city, country from which a particular piece lab equipment was acquired. Authors are encouraged to place Brand and Model number (no ® symbol required!) before the equipment. Thus, microscopical measurements should be taken using NOT "...a compound light microscope (Leica®, Model DM RB, Leica Microsystems (Danaher), Wetzlar, Germany) loaded with Nomarski optics...." but simply "...a Leica DM RB compound microscope with DIC optics."

And please, people! In this day of chemical, cultural, molecular, and population analyses, there is no longer a need to encompass "morphological" and "anatomical" using the needlessly long term: "morpho-anatomical." "Morphology" which covers both anatomy as well as features visible to the naked eye, may be used all by itself! [Species circumscribed relying only on anatomical characters are still understood to be based on a 'morphological species' concept.]

Diameter vs. width—We know. It is extremely tempting to refer to the short dimension of a hypha measured with 1000×-power as a 'width' (which contrasts with the long dimension, the 'length'). Unfortunately using 'width' for diameter conveys the impression that the object measured is two-dimensional. It isn't—it is **three**-dimensional, and what you have measured is the diameter. Rather than write out 'in diameter' in your technical descriptions and keys, try placing diam. (or even diam without the full stop) after the unit (e.g.: "23 µm diam" or "23 µm diam."). Mycotaxon accepts both styles but does request consistency! This has the added bonus of reminding readers that what we see through a microscope lens only seems to exist in one plane.

Mycotaxon 132(4) presents 31 research papers by 132 authors representing 18 countries and revised by 48 expert reviewers, adds two new mycobiotas to its website, and reviews three excellent books published in late 2016.

Within its pages are THREE new genera (*Anisogenispora, Ellismarsporium, Stanhughesiella*) and 22 species new to science representing *Acumispora, Anisogenispora, Minimelanolocus,* and *Paliphora* from Brazil; *Bactrodesmiastrum* and *Triadelphia* from the United States; *Baeomyces, Ellisembia, Endophragmiella, Lirula, Perenniporia, Phaeomonilia, Pseudocercospora, Repetophragma, Russula,* and *Sporidesmiopsis* from China; *Colpoma* from Colombia; *Inocybe* and *Thelephora* from Pakistan; and *Russula* from France.

We also offer 12 new combinations or replacement names in *Drepanopeziza, Ellismarsporium, Stanhughesiella,* and *Triadelphia* and keys to species in *Acumispora, Ellismarsporium, Phaeomonilia, Pyrenulaceae & Trypetheliaceae* in Vietnam, *Sporidesmiopsis,* and *Triadelphia.*

Range extensions and/or new hosts for previously named taxa are cited for *Myriospora* in the Czech Republic & Italy; *Helotiales* & *Rhytismatales* in Turkey; *Huneckia* & *Flavoplaca* in China; and *Amanita* in Mexico's Tehuacán-Cuicatlán Biosphere Reserve. Phylogenetic support and the ectomycorrhizal association with *Quercus* are confirmed for *Amanita pallidorosea* in Pakistan while *Hypoderma rubi* is shown on two new hosts in Slovakia.

Finally, in his clarification of *Glischroderma,* Mycotaxon co-founder Hennebert untangles a long-standing confusion within *Glischroderma-Pachyphlodes-Ostraderma* in honor of his former collegue and fellow co-founder, Dick Korf.

Warm regards,

Lorelei L. Norvell (*Editor-in-Chief*)
10 January 2018

2018 Mycotaxon submission procedure

Prospective Mycotaxon authors should download the Mycotaxon 2018 guide, review & submission forms, and Mycotaxon sample manuscript by clicking the 'file download page' link on our Instructions to Authors page before preparing their manuscript. This page summarizes our '4-step' submission process.

1—Peer review: Authors first contact two (for journal papers) or three (for annotated species 'weblists') peer reviewers before sending them formatted text & illustration files and the appropriate 2018 Mycotaxon journal or weblist reviewer comment form. Experts return revisions & comments to both the *Editor-in-Chief* <editor@mycotaxon.com> and authors. The authors correct their files before submitting their manuscript to the *Nomenclature Editor*.

2—Nomenclatural review: Email all **error-free** text and illustration files to the *Nomenclature Editor* <PennycookS@LandcareResearch.co.nz>. Place **first author surname** + **genus** + 'Mycotaxon' on the subject line; list title & coauthors and peer reviewer names & Email addresses in the message. The Nomenclature Editor will (i) reply immediately with the accession number and (2) return his notes with suggested revisions to the author(s) and *Editor-in-Chief* after a few weeks.

3—Final submission: Authors should consult experts and thoroughly revise and proof-read manuscripts to prepare error-free text and image files ready for immediate publication. **Label** the final submission email to the *Editor-in-Chief* <editor@mycotaxon.com> and **all** files & forms with **accession number;** attach the **(i)** 2017 submission form, **(ii)** labeled text files, **(iii)** labeled jpg files, and [required] **(iv)** FN, IF, or MB identification verification for each new name. The *Editor-in-Chief* usually contacts all coauthors and expert reviewers within two weeks of final submission, but please wait at least 14 days before sending a follow-up query (without attachments).

4—Final editorial review: Files with errors will be rejected or returned for revision. The *Editor-in-Chief* conducts a final grammatical and scientific review and returns her editorial revisions to all expert reviewers and coauthors for final author approval. Author-approved files are placed in the publication queue.

The PDF proof and bibliographic & nomenclatural index entries will be sent to all coauthors for final inspection. After PDF processing, the *Editor-in-Chief* corrects only PDF editorial/conversion and index entry errors; corrections of all other errors are listed in the Errata of a subsequent issue for no charge. Authors should arrange payment of page charges and optional open access fees with the *Business Manager* <subscriptions@mycotaxon.com> at this time.

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Mycotaxon publishes four quarterly issues per year. Both open access and subscription articles are offered.

MYCOTAXON

ISSN (print) 0093-4666 (online) 2154-8889 Mycotaxon, Ltd. ©2017

October–December 2017—Volume 132, pp. 707–721

https://doi.org/10.5248/132.707

Russula vinosoflavescens sp. nov., from deciduous forests of Northern Alsace, France

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Abstract—Based on morphological, molecular, and ecological data, a new species of *Russula* sect. *Russula*, found on several occasions under deciduous trees in Northern Alsace is described and illustrated as: *Russula vinosoflavescens*, belonging to *R.* subsect. *Sardoninae*.

Key words—*Basidiomycota*, *Russulaceae*, ITS, *Russula persicina*, phylogeny

Introduction

Russula Pers. (*Russulales*, *Basidiomycota*) is an ectomycorrhizal genus with a world-wide distribution that is particularly well studied in temperate regions, notably in Europe (Romagnesi 1967; Sarnari 1998, 2005). The ectomycorrhizal associations, which often involve a selective fungus–plant partnership, were sometimes advantageously used to delimit infrageneric taxa. Such has been the case for *R.* subsect. *Sardoninae* Singer (Sarnari 1998, emend.), which is divided into series—provisionally defined by Sarnari (1998)—comprising, on one hand, species strictly associated with conifers (*R.* ser. *Sardonia* and *R.* ser. *Sanguinea*, both essentially corresponding to *R.* subsect. *Sardoninae* as conceived by Romagnesi 1967, 1987) and, on the other hand, species associated with deciduous trees, sometimes in a host-specific relationship (*R.* ser. *Exalbicans* = *R.* subsect. *Exalbicantinae* Singer as retained by Romagnesi, with species found only under birches) and sometimes with a broader host-range (*R.* ser. *Persicina* = *R.* subsect. *Persicinae* Romagn., species that can be found under oaks, hornbeams, beeches, birches, chestnuts, poplars, willows).

Table 1. *Russula*, *Gymnomyces*, and uncultured specimens with GenBank and UNITE sequence accession numbers used in the molecular analyses.

Species	Specimen	Country	Sequence
G. gilkeyae	JT 2572	USA	AY239346
G. monosporus	OSC 117360	USA	EU669222
root sample (uncultured)	—	France	JQ890299
	—	—	JN197654
	—	USA	EF434062
	—	USA	GU997950
	—	USA	GU997948
R. americana	F 18871	USA	HQ604839
R. aquosa	TU 101831	Estonia	UDB015988
	TU 101708	Estonia	UDB011290
R. atrorubens	TU 101691	Estonia	UDB011358
	TU 101851	Estonia	UDB016006
R. bresadolae ("*R. atropurpurea*")	HUE 178	Germany	UDB000313
	PRM 858109	Czech Republic	HG423574
R. cavipes	RT 9149	Italy	JF908681
	HUE 163	Germany	AF418623
Russula cf. "*ammodica*"	F 18874	USA	HQ604840
R. citrinochlora	TU 101905	Norway	UDB016045
	20024	Sweden	UDB002550
R. consobrina	TU 118108	Estonia	UDB011223
	TU 106965	Estonia	UDB011207
R. depallens	TU 101829	Estonia	UDB015986
	TU 101838	Estonia	UDB015994
R. emetica	F 14309	—	AY228360
	DG 18	United Kingdom	JQ888196
	DG 44	United Kingdom	UDB001628
R. exalbicans	2-1117IS76	—	AY061674
R. fageticola ("*R. mairei*")	FH 12262	Germany	KT934013
R. fageticola ("*R. nobilis*")	HUE 054	Germany	UDB000346
R. fellea	HUE 218	Germany	UDB000345
	HUE 177	Germany	UDB000314
R. fragilis	UE 2006-11-08-22	Italy	UDB018436
	UE 2004-20-09-04	Sweden	UDB018434
R. gracillima	TU 101725	Estonia	UDB011361
	TU 106437	Estonia	UDB011176
R. luteotacta	TU 106379	Estonia	UDB011166
	FH 12-187	Germany	KT933991
R. ochroleuca	TU 118113	Estonia	UDB011228
	LW 115	Germany	UDB000295
R. persicina	TU 101826	Estonia	UDB015984
	TU 106950	Estonia	UDB011196
R. pumila	F 133	Finland	UDB009582
	L 3X87	—	FM993279
R. queletii	FH 12-237	Germany	KT934007
	RT 5140	Italy	JF908668

R. renidens	TU 101809	Estonia	UDB015975
	JR 1758F [IT]	Finland	UDB011117
R. rhodomelanea	FH 2011-BT307	Germany	UDB018429
	IB 92/451 [HT]	Italy	UDB018435
R. sanguinea	TU 106710	Estonia	UDB019728
	FH 12240	Germany	KT934008
R. sardonia	TU 106951	Estonia	UDB011197
	FH 12215	Germany	KT933999
R. silvestris	JK 11080504	Sweden	UDB018431
	JK 11080802	Sweden	UDB018430
R. thindii [HT]	BSHC KD11-095	India	KM386693
R. torulosa	TU 106444	Estonia	UDB011177
	TU 101626	Italy	UDB016261
R. vinosoflavescens	JMT 05081006	France	UDB031189
	JMT 08081512	France	UDB031188
	JMT 14090502 [HT]	France	UDB031187
	JMT 05081007	France	UDB031190
	JMT 10080701	France	UDB024104
	JMT 13090715	France	UDB024105
Outgroup			
R. puellula ("*R. puellaris*")	MC 01-502	Denmark	UDB000010
R. cuprea	FH 12250	Germany	KT934010
R. olivobrunnea	TU 101883	Finland	UDB016034

[HT] holotype; [IT] isotype.

The aim of this paper is to introduce a new *Russula* species occurring in deciduous forests of Northern Alsace (NE France) and belonging to *R.* subsect. *Sardoninae*. Our initial morphological concept of the species, based on several collections from various localities, is fully supported by molecular data. ITS sequence analysis shows that the different collections form a well-supported clade in the *Russula* phylogenetic tree.

Materials & methods

Sampling

All collections of the new taxon were made by Jean Michel Trendel and are deposited in GENT Herbarium. These collections are referred to with an eight-digit code YYMMDDXX (year; month; day; collection number). All collecting sites are located in Northern Alsace (NE France); the code of the municipality is that assigned by the National Institute for statistics and economic studies (INSEE); names (in quotation marks) of forest or place are those indicated on the topographic maps (1:25000 scale) from the Institut national de l'information géographique et forestière (IGN); map coordinates of the collections refer to the Universal Transverse Mercator (UTM) 32N kilometer grid system; geological data (underlying rock) were mainly obtained

from geological maps (1:50000) edited by the Bureau de Recherches Géologiques et Minières (BRGM).

Morphological analysis

Specimens were photographed in situ. The pictures are available at http://www2.muse.it/russulales-news/. Microscopic observations were carried out on fresh material. Pileipellis elements were studied on radial sections made by hand midway from the cap margin, mounted either in SDS Congo red (Clémençon 1999) or in distilled water. The search for acido-resistant encrustations was performed by staining with Ziehl carbol fuchsin followed by a rapid differentiation using a 1M HCl solution. Pileocystidia content was revealed using sulfovanillin (SV) freshly prepared with a 50% or 80% H_2SO_4 aqueous solution. Hymenial elements were studied in the above-mentioned observation media. In some cases, additional controls were carried out on very fine cap sections made from dried material and further rehydrated in a moisture-saturated closed chamber for 24 h before observation in water. Basidiospores (from spore deposits) were examined in Melzer's reagent and spore measurements (ornamentation excluded) were recorded randomly for 300 spores (6 collections) in side view. Measurements are given as (MINa) [AVa – 2*SD]–*Ava*–*AVb*–[AVb + 2*SD] (MAXb), with AVa = lowest mean value for the measured collections and MINa the minimum value corresponding with this mean value, AVb = greatest mean value and MAXb the maximum value corresponding with this mean value, and SD = standard deviation calculated for the measurements of one collection (minimum and maximum value are only given if not in the 2*SD-interval). Q stands for spore "length/width ratio" and is given as (MINQa)–*Qa*–*Qb*–(MAXQb) with Qa and Qb being the lowest, and the highest respectively, mean ratio for the measured specimen. The colour of the spore deposit, referring to Romagnesi's (1967) scale, was assessed against a personal chart (JMT) and the Dagron's chart (unpublished). Macrochemical reactions were determined using $FeSO_4$ in crystalline form, a 4% phenol solution, and a strong Guaiac solution made of permanently soaked Guaiac wood in 95% ethanol.

Molecular analysis

Total genomic DNA was extracted from dried material according to Nuytinck & Verbeken (2003), with modifications described in Van de Putte et al. (2010). The ITS region was amplified using the primers ITS1F–ITS4 (White et al. 1990, Gardes & Bruns 1993) and with polymerase PerfectTAQ (5 PRIME, Hilden, Germany) in accordance with the manufacturer's recommendation. PCR amplification followed Eberhardt (2012), and the PCR products were purified using the Qiaquick PCR Purification Kit (Qiagen, Hilden, Germany) and directly sequenced with BigDye 3.1 technology (Applied Biosystems, now Thermo Fisher Scientific, Wilmington, USA). Specimens JMT-05081006, JMT-05081007, and JMT-05081512 were extracted and sequenced in Muséum National d'Histoire Naturelle de Paris (Marc-André Selosse) following Séne et al. (2015).

Raw sequences were edited in the BioEdit Sequence Alignment Editor version 7.2.5 (Hall, 2013) or Sequencher version 4.8 (Gene Codes Corporation). Edited sequences

were aligned by MAFFT version 7 using the strategy E-INS-i (Katoh & Standley 2013). Maximum-likelihood searches for tree building were carried out locally with 100 replicates with the GTR+GAMMA model, selecting the best solution of all replicates analysis in RaXML 8.1.12 (Stamatakis 2014). Fast bootstrap searches were done locally or through the CIPRES Science Gateway (Miller et al. 2010) with 10 000 replicates.

The final alignment included a total number of 67 ITS sequences, with 21 sequences corresponding to the current concept of *R.* subsect. *Sardoninae* (Sarnari 1998). Except for the *R. vinosoflavescens* collections cited as studied material all sequences were retrieved from GenBank or UNITE (Table 1). The tree with the highest log likelihood (–4523.1303) is shown. Initial tree(s) for the heuristic search were obtained automatically by applying the Maximum Parsimony method.

Taxonomy

Russula vinosoflavescens Trendel & F. Hampe, **sp. nov.** Figures 1, 2

MycoBank MB 819428

Differs from *Russula persicina* by its colour range, its mild or only slightly acrid taste, its reticulate spore ornamentation, and the presence of granular pigments in cuticular hyphae.

Type: France, Alsace, Morsbronn-les-Bains (67303), "Niederwald", UTM 32N: 0406318/5419158, 213 m alt., on argillaceous soil with eumull humus (underlying rock: upper Keuper red marls), under *Quercus robur* and *Carpinus betulus* with some *Fagus sylvatica* nearby, in an area characterized by calcicolous mycoflora with numerous *Phlegmacium* (*Cortinarius*) species, 5 Sept. 2014, JMT-14090502 (**Holotype**, GENT; UNITE UDB031187).

Etymology: Referring to the purplish-red wine-coloured (vinoso) cap and the tendency of the cap to become brown-yellowish or ochraceous (flavescens) as well as when handling the stipe.

Pileus 4.0–6.5 cm diam., more or less fleshy, rather firm to very firm but with margin occasionally slightly elastic, often irregular, at times knotty, convex-flattened with the margin sometimes incurved or even inrolled, then broadly but shallowly depressed; margin not or shortly sulcate, often flexuose-undulate or lobed, in some cases showing a very clear, whitish border extending to the edge of the gills (giving a "festooned" appearance); surface rugulose, more or less radially veined, frequently uneven-bumpy in the centre, a little shiny in wet conditions, but soon dry (except sometimes in the centre which remains a little greasy) and then more mat, purple-red, carmine-red, vinaceous-red, somewhat violet, rather vivid, but frequently paler, livid pinkish-vinaceous, with mauve (lilac) greyish shades that can entirely replace the reddish tinges, even more clearly greyish purple at the margin, becoming yellowish cream-ochraceous from the centre or showing locally ochre-bistre areas merging in the reddish and greyish mauve tints, sometimes becoming almost totally beige-brown,

ochreous-brown, with livid purple-violet glints mostly near the margin and a residual purple-brown at centre. Lamellae adnate or attenuated-subdecurrent, sometimes sub-emarginate, with a variable number of lamellulae, crowded to rather spaced, interveined, anastomosing and more or less forked at every level, in some cases more particularly near the stem (exceptionally regular, without any forking or anastomosing), (sub)acute at the cap margin (rarely subobtuse), narrow (0.3–0.5 cm, exceptionally broader ≤0.7 cm), whitish or very pale cream; edge entire but often somewhat irregularly wavy. Stipe 2–6 × 0.9–1.5(–2) cm, cylindrical or slightly enlarged downwards, usually rounded at the base (in a few cases tapering), sometimes eccentric, firm to almost hard, with a firm medulla (exceptionally hollow-fistulous); surface nearly smooth, finely wrinkled, white with occasionally a purple tinge (in one case remarkably grey-purplish, somewhat brownish), distinctly yellowing (dirty, often with greyish-brown shades) when handled or bruised. Context white, in the pileus almost unchanging, in medulla of stipe slightly yellowing, sometimes a little purple-violet beneath the cuticle in the most coloured forms; taste mild (or almost mild, occasionally with an unpleasant aftertaste, somewhat bitter), mild to slightly (and sometimes volatile) acrid in the gills, exceptionally more strongly acrid; smell not distinctive.

Macrochemical reactions $FeSO_4$: rose-orange; Phenol: brown; Guaiac: in most cases reacting on the stem surface almost immediately (<2 s, in one case more slowly), but of little intensity at the beginning, developing (10–15 s) in blue of medium intensity, exceptionally with a stronger reaction, (dark blue); on gills, the reaction developing slowly and weakly (blue-green to light blue).

Spore print cream, II(a)b–c.

Basidiospores subglobose to broadly ellipsoid, 6.4–*7.2–8.1*–9.0 × 5.9–*6.5–6.9*–7.7 µm (n = 300), Q = 1.06–*1.11–1.20*–1.30; ornamentation amyloid, often with incompletely amyloid warts; warts conical-obtuse, or more acute, sometimes somewhat truncated, generally around 0.4–0.8 µm high, but also frequently reaching 1.0 µm or higher, sometimes locally catenulate, interconnected by crests or more frequently by (often very fine) connectives, forming a well-developed and often nearly complete (with numerous meshes) reticulum, which may appear confused in some cases; suprahilar plage moderately amyloid, more or less bordered by small warts or low crests. Basidia 4-spored, 42–57 × 9.5–12.5 µm, including sterigmata (about 5 µm long). Pleuromacrocystidia 60–90 × 10.5–14.5 µm, numerous, fusiform or more or less clavate, most commonly with a pointed appendage, which can show constrictions, more rarely ending in a short obtuse protuberance,

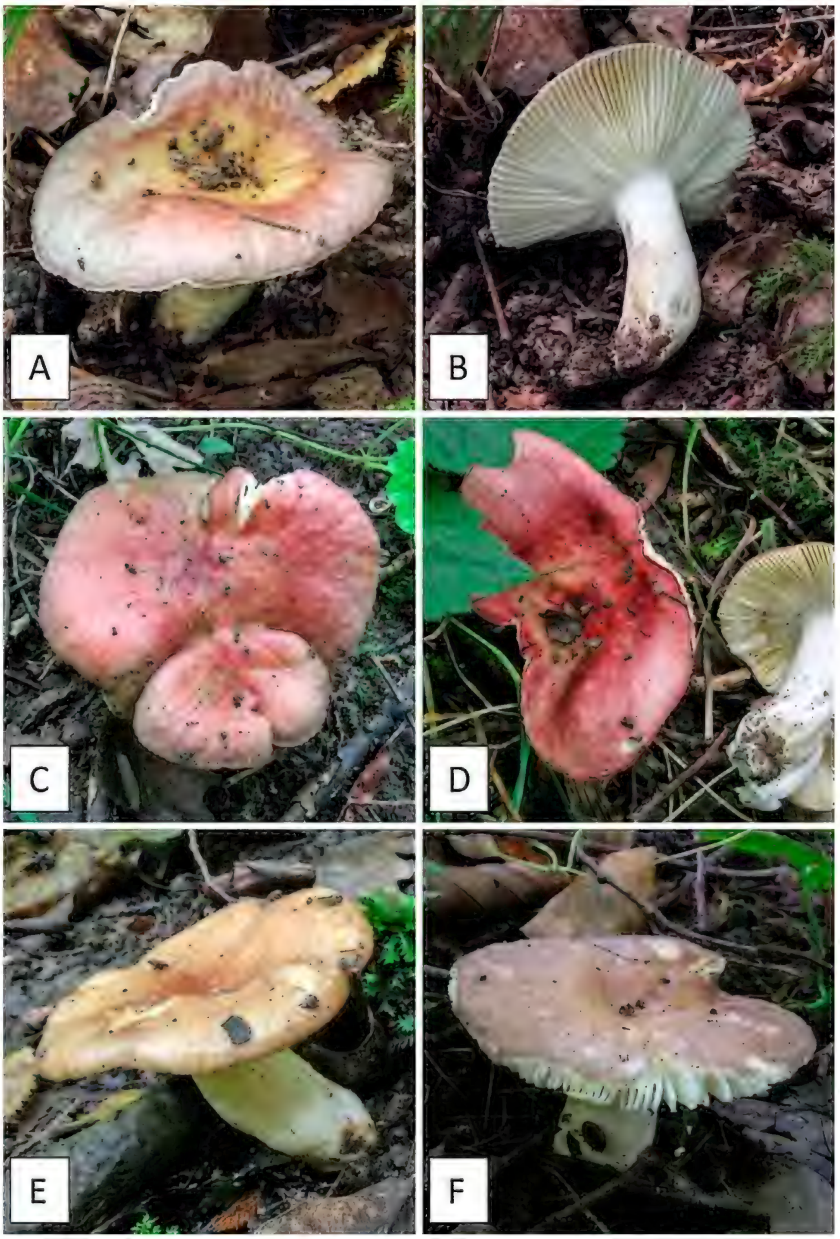

FIG. 1. *Russula vinosoflavescens*: colour forms observed. A, B. holotype, collection JMT-14090502; C. collection JMT-05082042, with marked reddish pigmentation; D. collection JMT-05081006, with marked reddish pigmentation; E. collection JMT-08081512, with predominating ochraceous colour; F. collection JMT-10080701, with mauve–lilac colour reminiscent of a *Griseinae*.

strongly staining with SV. Pileipellis composed of hyphae containing reddish-violaceous granular pigments; epicuticular elements (2.0–)2.5–4.0 µm diam., sometimes branched, flexuose, sometimes inflated up to 5.5 µm; terminal cell obtuse, or slightly thickened with a short appendage, also subcapitulate, or (exceptionally) pear-shaped ≤7.0 µm diam., but also conversely more or less attenuated (sometimes abruptly). Pileocystidia of two types; type 1 usually unicellular (occasionally with 1 septum), rarely bifid, clavate–fusiform, less frequently cylindric, 4.0–9.5 µm diam., often appendiculate–capitulate or showing an obtuse apical protuberance, sometimes slender, (at least 120 µm long, narrowed at the base to 2.5–3.0 µm diam.), with a content reacting variably depending on the collection—but also on a cuticular section—when treated with SV, staining (rather) strongly (grey-blackish) or weakly (grey-pinkish) or even remaining inert (pinkish); type 2 lactiferoid (some clearly termini of ascending lactifers), pluriseptate, more or less regularly cylindrical, 6.0–10.5 µm diam., with variably shaped terminal elements that sometimes taper (with possible constrictions), sometimes are somewhat thickened or subclavate, or with type 1 type appendages, originating in the deeper pellis, distinctly reacting with SV (except in one specimen where the granular content of pileocystidia type 2 is inert or reacts only very weakly in SV); without encrusted elements after treatment with Ziehl fuchsin.

Ecology & distribution—Under deciduous trees, associated with *Carpinus betulus,* or *Quercus* (*Q. robur* or *Q. petraea*), or both (possibly also with *Fagus sylvatica*), in a rather wet environment (possibly periodically drier), on more or less argillaceous soils, neutral to superficially slightly acidic, usually nutrient-rich with a rather high base saturation level (calcium-rich), with mesotrophic to eutrophic mull humus. Phenology: late July to early September (summer fruiting). Known only from six sites (9 collections) in Northern Alsace (France).

Additional specimens examined—**FRANCE**, **Alsace**. **Bas-Rhin**, Mattstall, commune associated with Lembach (67263), 'Sauerhald', UTM 32N: 0409918/5426543, alt. 203 m, underlying rock: Upper Muschelkalk marly calcareous formation, under *Quercus*, *Carpinus*, *Fagus* (forest locally rich in orchids, e.g., *Epipactis microphylla*), JMT-13090715 (GENT, UNITE: UDB024105); Dauendorf (67087), 'Herrenwald', 0402753/5410066, 168 m, Loess from the Quaternary (and more ancient alluvial deposits?), in a wet environment, nitrogen-rich and with a high base saturation level, under *Carpinus, Quercus, Alnus glutinosa, Fraxinus excelsior, Ulmus* sp., and with a herbaceous layer comprising *Allium ursinum, Carex sylvatica, Circaea lutetiana, Geum urbanum, Glechoma hederacea, Paris quadrifolia, Stachys sylvatica*, JMT-10080701 (GENT, UDB024104); 0402762/5409965, 171 m, Loess from the Quaternary (and more ancient alluvial deposits?), under *Carpinus*, *Quercus*, JMT-05082042 (GENT);

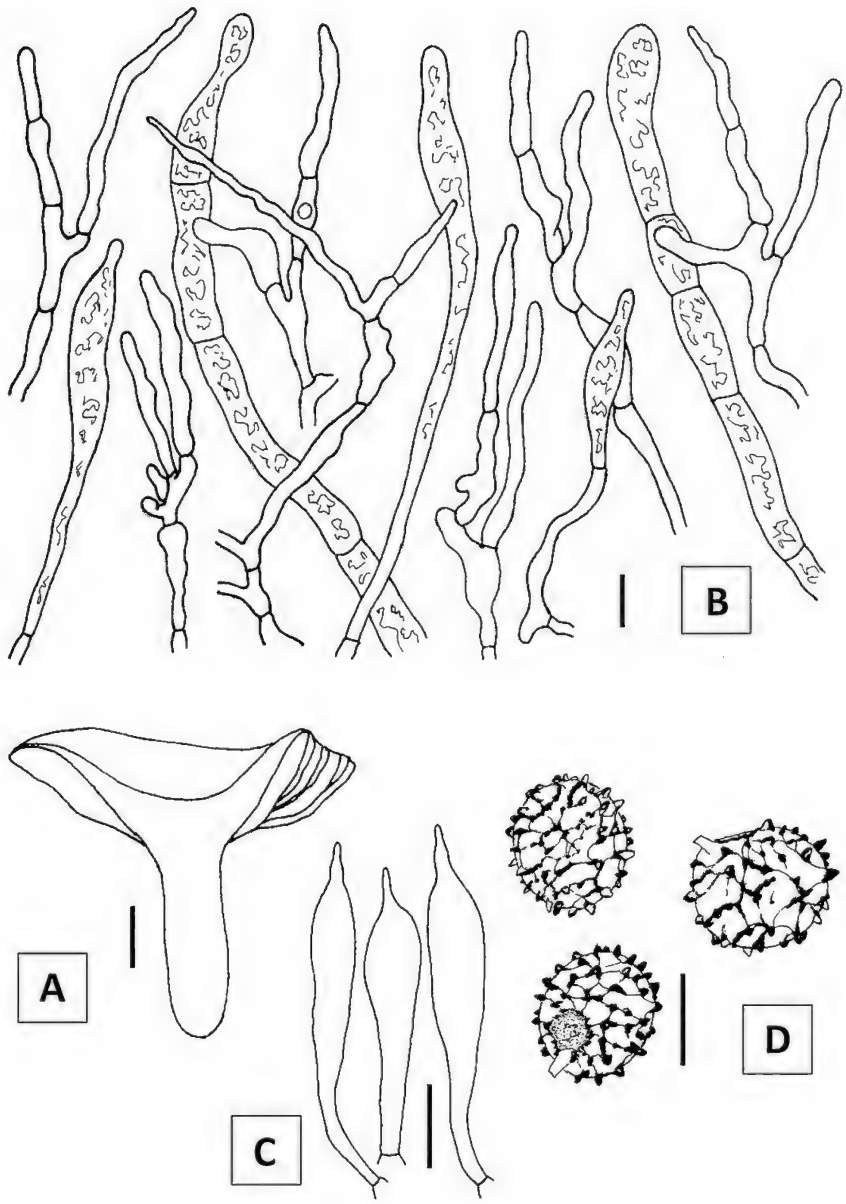

Fig. 2. *Russula vinosoflavescens* (holotype, collection JMT-14090502). A. fruitbody in sectional view; B. pileus epicutis: pileocystidia (with content shown schematically) and hyphal terminal elements; C. hymenial cystidia on gill sides; D. spores as observed in Melzer's reagent. Scale bars: A = 1 cm; B = 10 µm; C = 20 µm; D = 5 µm.

Bettwiller (67036), 'Buchwald', 0365394/5416535, 347 m, Upper Muschelkalk marly calcareous formation, under *Quercus*, *Carpinus*, with some *Fagus* and *Prunus avium*, JMT-05081006 (GENT, UDB031189) and JMT-05081007 (GENT, UDB031190), most likely belonging to the same mycelium; Forstheim (67141), 'der Wald', 0405631/5415509, 211 m, Pliocene sands and clays, wet environment, under *Quercus*, *Carpinus*, *Populus tremula* with *Russula lutensis* Romagn. and *R. rutila* Romagn., JMT-08081512 (GENT, UDB031188); Drusenheim (67106), 'Barrwald', approximately 0420900/5401000, 124 m, Quaternary alluvial deposits, wet environment, on bare blackish ground, with *Carpinus*, *Quercus*, *Alnus glutinosa*, *Fraxinus excelsior*, 25/07/1981, JMT-81072501 (GENT, spore print only available).

Discussion

Molecular analysis

The six ITS sequences of the newly described *R. vinosoflavescens* form an independent clade, which receives high bootstrap support (Fig. 3). The clade corresponding to *R. vinosoflavescens* is nested within a large, supported (bootstrap value 75) clade that includes the typical European representatives of *R.* subsect. *Sardoninae* (*R. sardonia* Fr., *R. queletii* Fr., *R. torulosa* Bres.). Beside these, it contains a number of species (e.g., *R. cavipes* Britzelm., *R. exalbicans* (Pers.) Melzer & Zvára, *R. gracillima* Jul. Schäff., *R. luteotacta* Rea, *R. persicina* Krombh., *R. renidens* Ruots. et al., *R. sanguinea* Fr.) included by Sarnari (1998) in his emended concept of *R.* subsect. *Sardoninae* but attributed to different (although closely related) infrageneric taxa by previous authors (Romagnesi 1967, Singer 1986, Bon 1988). In addition to the abovementioned species, which fairly well represent *R.* subsect. *Sardoninae* sensu Sarnari, the clade includes extra-European *Sardoninae* species such as *R. thindii* K. Das & S.L. Miller and some poorly known species with an uncertain systematic position (e.g., *R. americana* Singer, *R. citrinochlora* Singer).

The deeper phylogenetic relationships within the Sardoninae clade as well as its external relationships with *R. fellea* (Fr.) Fr., *R. consobrina* (Fr.) Fr., *R. ochroleuca* Fr., and the large clade representing *R.* subsect. *Russula* s.l. (including a sequence of the generic type *R. emetica* (Schaeff.) Pers.) remain poorly resolved in the ITS analysis. Within the Sardoninae clade, *R. vinosoflavescens* occupies a rather isolated position in a weakly supported subclade containing *R. renidens* and samples identified as *R. citrinochlora*.

Morphological analysis

Despite its mild taste (in most cases only weakly acrid in gills), *R. vinosoflavescens* shows a combination of characters—a more or less fleshy firm pileus, cuticle often rugulose with polychromic colours, cream spore

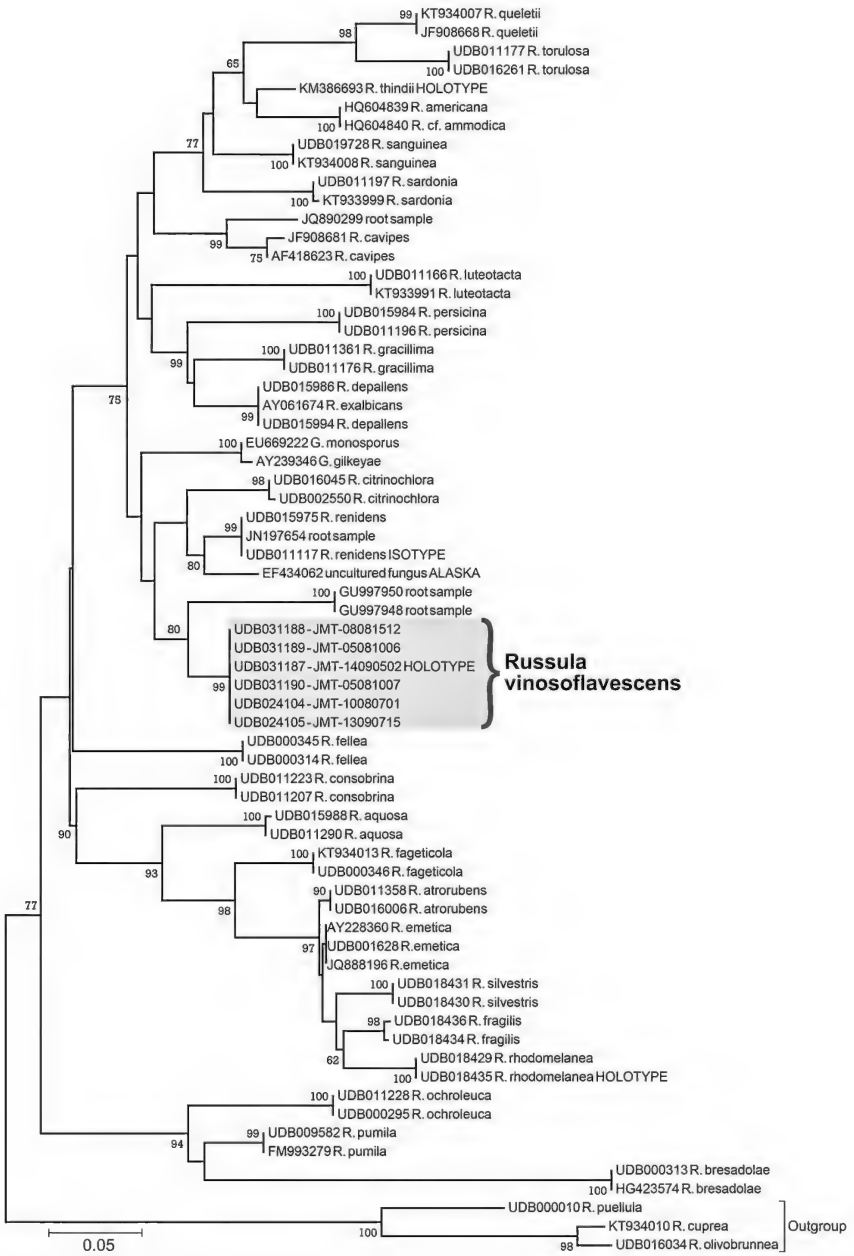

FIG. 3. Molecular phylogenetic analysis by Maximum Likelihood method-based tree with the highest log likelihood (–4523.1303), based on ITS sequences.

print, well-characterised and non-encrusted pileocystidia—that is consistent with its position in *R.* subsect. *Sardoninae* sensu Sarnari. Moreover, by its habitus, somewhat decurrent narrow gills, and clear yellowing of its stipe when bruised, this species is very reminiscent of certain forms of *R. persicina*. *Russula vinosoflavescens* differs, however, unambiguously from the latter by its colours, which are never 'pure' red. Indeed, even in its reddest forms, the cap always displays some purple-vinaceous tinges, presumably reflecting the existence of one or several blue pigments, occurring in sufficient amount to significantly shade the red ones. The presence of these blue pigments becomes even more apparent when grey-mauve (lilac) tints replace—sometimes completely—the reddish colouring. In addition, this russula appears to fade readily to yellowish ochre, or even brown-beige, and therefore colour forms devoid of any reddish or bluish shades might be expected.

Other striking features are the often rugulose surface of the cuticle and the strong tendency of the lamellae to become anastomosed-forked, though it should be kept in mind that these characters are variable. The same is true for the variability of the speed and intensity of the Guaiac reaction, which is mostly in an average position on the reactivity scale.

One of the most striking microscopical features is the aggregation of pigments into granules (sometimes distinctly combining red and blue pigments) that are generally easily observed in the cap cuticular hyphae. The cuticular structure of specimens for which we were unable to examine in fresh condition was re-examined in dried material. Concerning the least pigmented collection JMT-08081512 (Fig. 1-E), cuticular sections from the central part of the cap—apparently the richest in residual red and blue pigments—revealed the presence of pigmented grains. Our search was much less conclusive for the vividly coloured specimens JMT-05081006 (Fig. 1-D), and even if we were able to show the presence of sparse coloured granules, it appears that a significant amount of pigment is either vacuolar (soluble) or at least not distinctly granular. In addition, examination of the cuticle of collection JMT-05082042 (Fig. 1-C), not studied in a fresh state, clearly revealed the presence of pigmented granules.

As reported by Romagnesi (1967) and Sarnari (1998), granular pigments are highly characteristic of *R.* subg. *Heterophyllidia* but are also found occasionally in some species belonging to other groups. In this respect, one should especially mention *R. renidens*, a Nordic russula growing under birches, which shows abundant granular red-purplish pigments, the latter probably co-occurring in a soluble form accounting for the intensity of its colours (Sarnari 1998). A similar situation may also exist for some of our vividly coloured collections

(notably JMT-05081006 and JMT-05081007). Indeed, it seems likely that pigment aggregates contribute less efficiently to global colouring compared to those in solution, and that a strong predominance of granular pigments over their soluble counterparts may explain the relative paleness of some of our collections.

The morphology of the terminal hyphal cells of the epicuticular elements appears too variable to be usable for species recognition. On the other hand, pileocystidial shape seems informative at species level. It is also significant that this characteristic can be found in almost all members of *R.* subsect. *Sardoninae* as defined by Sarnari, where the new species belongs.

Another important diagnostic feature is the strongly reticulate spore ornamentation that distinguishes *R. vinosoflavescens* from similar species sharing the same cream spore print and also growing under deciduous trees, such as *R. persicina* or the birch associates, *R. exalbicans* and *R. renidens*.

Ecology

Within *Russula* subsect. *Sardoninae*, partitioned by Sarnari (1998) into ecological series based on *Russula*/tree partnerships, *R. vinosoflavescens* fits in *R.* ser. *Persicina,* devoted to species associated with broadleaf trees (but not strictly with birches); the other series cover species linked strictly to either conifers (*R.* ser. *Sardonia* and *R.* ser. *Sanguinea*) or birches (*R.* ser. *Exalbicans*). Indeed, *R. vinosoflavescens* appears associated with oak *(Quercus robur* or *Q. petraea*) or hornbeam (*Carpinus betulus*) or both, the only trees present on all collecting sites. A wider host association might include beech (*Fagus sylvatica*, generally well represented in the forests of interest but sometimes rather far away from the fruiting bodies) or, less likely, aspen (*Populus tremula,* which can occur in more complex environments). Birch (*Betula* spp.), absent from all the prospected sites, should not be considered a potential associate. However, regarding Romagnesi's (1967) initial concept of *Persicinae*, which refers to "intermediate forms between *Emeticinae* and *Sardoninae* [both sensu Romagnesi!], with less reticulate spores and gills more decurrent or weeping than the former, and more purely red in colour than the latter" [a concept at least partly shared by Sarnari (1998)—"pileus pure red"], it becomes necessary to restrict Sarnari's *R.* ser. *Persicina* definition exclusively to ecology, as in *R. vinosoflavescens* colouration is not restricted to pure red and its spores are rather strongly reticulate. In his classification, Bon (1988) does not retain Romagnesi's *Persicinae* group but treats the different taxa of *R. persicina* in his emended *R.* subsect. *Exalbicantinae.* In this context, *R. vinosoflavescens* would take its place beside *R. exalbicans*, which also often displays washed-out greyish

colours, and *R. renidens*, genetically a very closely related species sharing some outstanding morphological features such as pigments that are at least partly granular or lamellae that are more or less forked.

Acknowledgments

We are extremely thankful to Josie Lambourdière and Prof. Marc-André Selosse (Muséum national d'Histoire Naturelle, Paris) for some additional molecular analyses, and to Dr. Philippe Schaeffer for helpful discussions. Dr. Ursula Eberhardt and Geoffrey Kibby are acknowledged for useful comments and reviewing the paper.

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MYCOTAXON

ISSN (print) 0093-4666 (online) 2154-8889 Mycotaxon, Ltd. ©2017

October–December 2017—Volume 132, pp. 723–744

https://doi.org/10.5248/132.723

Triadelphia acericola and *T. centroseptata* spp. nov., and a synopsis of the genus

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Abstract—A new hyphomycete species found during a collection of microfungi from plant debris and decaying wood in Connecticut, USA, is described and illustrated here as *Triadelphia acericola*. The new species produces four conidial forms: form (a), the predominant form, is cylindrical and 2-septate, with the apical septum covered by a wide dark band; form (b) is oblong or ellipsoidal and 1-septate; form (d) is clavate and pluriseptate, with the middle transverse septum covered by a dark band; and form (f) is globose. Literature on all published *Triadelphia* names is reviewed, and a comparative synopsis of the genus and a key to *Triadelphia* species are provided. "*Triadelphia centroseptata*" nom. inval. is validated by designation of a holotype, and *T. archontophoenicicola* nom. nov. is proposed to replace the illegitimate homonym, *T. australiensis* Joanne E. Taylor et al.

Key words—*Acer*, anamorph, nomenclature, pleomorphic, saprobe

Introduction

Triadelphia was erected by Shearer & Crane (1971) as a monotypic genus typified by *T. heterospora*. The generic concept of *Triadelphia* was originally described as: "Conidiogenous cells subspherical, subhyaline to dark colored, producing conidia from a very limited area at the apex. Conidia readily deciduous, leaving a pore when detached, cylindrical, rounded at the apex, rounded to slightly truncate at base, dark colored, and septate." (Shearer & Crane 1971). *Triadelphia heterospora* develops two different forms of conidia: 1) cylindrical and 2-septate and 2) broadly obclavate to ellipsoid and 4–7-septate;

both conidial forms have at least one septum covered by a dark band (Shearer & Crane 1971).

Hughes & Pirozynski (1973) transferred *Dicoccum inquinans* to *Triadelphia*. Maggi et al. (1978) described two new species: *T. loudetiae* and *T. pulvinata*. Constantinescu & Samson (1982), who studied herbarium specimens of *T. inquinans*, type specimens of *T. heterospora*, and ex-type cultures of *T. loudetiae* and *T. pulvinata,* found those species to be pleomorphic, developing 2–5 forms of conidia, and emended the generic description of *Triadelphia* to: "Conidiogenous cells arising from undifferentiated hyphae, hyaline or pale brown, flask-shaped, fusiform, cylindrical or clavate, solitary or agglomerated in sporodochium-like structures, mostly with determinate growth and producing one apical conidium. Conidia blastic, of at least 2 (sometimes 5) forms in every species: (a) cylindrical, brownish,1–2 septate; (b) clavate, dark brown, unispetate [sic]; (c & d) obclavate to acicular with a narrow long tip, hyaline or yellowish brown, multiseptate; (e) allantoid, hyaline or pale yellowish, 0–3-septate, sometimes also (f) obovate to broadly ellipsoidal, pale brown, unicellular." Constantinescu & Samson (1982) simultaneously described a new species, *T. romanica*, and transferred *Stemphyliomma alabamensis* to *Triadelphia*.

Kirk (1983) transferred *Sporidesmium uniseptatum* to *Triadelphia* based on conidiogenous cell morphology and conidial ontogeny and morphology, which were all similar to the previously published six *Triadelphia* species. Mercado Sierra & Castañeda-Ruiz (1983) published *T. stilboidea*, a synnematous species from Cuba, and Révay (1987) published *T. hungarica* from Hungary. Tzean & Chen (1989) described as new *T. diversa*; they also reviewed and compared eight *Triadelphia* species but did not include *T. stilboidea* or *T. hungarica* in their review and key.

Sutton (1989) described *Triadelphia australiensis*, a species with only one conidial form, although he acknowledged that all other *Triadelphia* species develop at least two forms of conidia. Matsushima (1989, 1995) described two new species, *T. queenslandica* and *T. synnematofera* (the second synnematous species in *Triadelphia*). Révay (1993) published her second new species, *T. morgoensis*, with a key to 12 species; she also noted that as *T. stilboidea* probably did not belong in *Triadelphia* due to its synnematous nature, she omitted *Triadelphia stilboidea* from her key.

Venkateshwarlu et al. (1997) added *T. centroseptata* to the genus. Manoharachary et al. (2001) described *T. corticola* as having two conidial "forms," which appear to represent the same form varying only in conidial width and shape: conidia in *T. corticola* share the same length, septation

characters, and conidiogenesis and belong to form (a) of Constantinescu & Samson (1982). The most recent species added to *Triadelphia* is *T. australiensis* Joanne E. Taylor et al. (Taylor & Hyde 2003). Of the eighteen species described in *Triadelphia,* "*T. centroseptata*" was invalidly published and is validated here.

Since the morphological characters and conidium ontogeny of our specimen collected in Windsor, Connecticut, cannot be ascribed to any previously described *Triadelphia* species, we propose it here as a new species, *T. acericola.*

Materials & methods

An undescribed hyphomycete was collected from a piece of inner bark of *Acer palmatum* during a collection of fungi from plant debris and decaying wood in a mixed forest, wood log piles, and a landscape garden at the Valley Laboratory, Windsor, CT, in June 2013. The specimen was placed in a paper bag and brought back to the laboratory. Isolation on to MEA and CMA was attempted in the same day. However, isolation was not successful. Therefore a small scalpel was used to remove fungal structures directly from the samples for morphological observation under an Olympus BX40 compound microscope. Conidiophores, conidia, and other fungal structures were mounted in 85% lactic acid or lacto-fuchsin (0.1 g acid fuchsin, 100 ml 85% lactic acid; Carmichael 1955). The fungal structures were microscopically observed and measured under Nomarski differential interference contrast optics. Photomicrographs were captured using an Olympus Microfire digital camera (Goleta, CA). Data of the fungal structure measurements were statistically analyzed using Microsoft Office Excel 2013 with 95% confidence interval of means. The results were presented as ranges and mean ± standard deviation as well as Q (ratio of conidial length/width).

Taxonomy

Triadelphia acericola D.W. Li, **sp. nov.** FIGS 1, 2A

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Differs from *Triadelphia heterospora*, *T. inquinans*, and *T. diversa* by not having conidial forms (c) and (e).

TYPE: USA, Connecticut, Windsor, 41°51′02″N 72°39′43″W, elevation 38 m, from wood of Japanese maple (*Acer palmatum* Thunb., *Sapindaceae*), 11 June 2013, De-Wei Li (**Holotype**, BPI 893194).

ETYMOLOGY: epithet is named after the genus *Acer* on which the fungus was collected.

COLONIES on natural substrate thinly diffuse, dark brown. Mycelium partly immersed and partly superficial, sparse, composed of colorless to pale brown, irregularly branched, smooth, septate hyphae. CONIDIOGENOUS CELLS monoblastic, small, 1-celled, smooth, ellipsoid, pale brown, 3 × 2.5 µm. CONIDIA apical, solitary, dry, pleomorphic, of four different forms (as categorized by Constantinescu & Samson, 1982): form (a) cylindrical, oblong, or clavate,

straight or slightly curved, smooth, thick-walled, light brown, (1–)2-septate, the apical septum covered with a dark band 2.1–4.3 µm thick, (11.5–)13.5–16 (–16.6) × (3.5–)4–5.5(–6) µm (mean = 14.5 ± 1.2 × 5 ± 0.6 µm, n = 33), Q = 2.2–4.1 (mean = 3.1), with rounded ends; form (b) oblong or ellipsoidal, smooth, pale brown, thick-walled, 6.5–11 × 3.5–4.5 µm, 1-septate at the middle or off center; form (d) clavate (incomplete), 17.5–19 × 6–7.5 µm, pluriseptate (often 4-septate), central cells pale brown to brown, with the middle transverse septum covered by a dark 2–2.5 µm wide band; smooth; end cells subhyaline to light brown, with truncate base; form (f) globose, subglobose, or ellipsoidal, pale brown to brown, unicellular, smooth, thick-walled, (4–)4.5–6(–6.5) × 4–4.5(–5) µm (mean = 5.1 ± 0.7 × 4.2 ± 0.3 µm, n = 12).

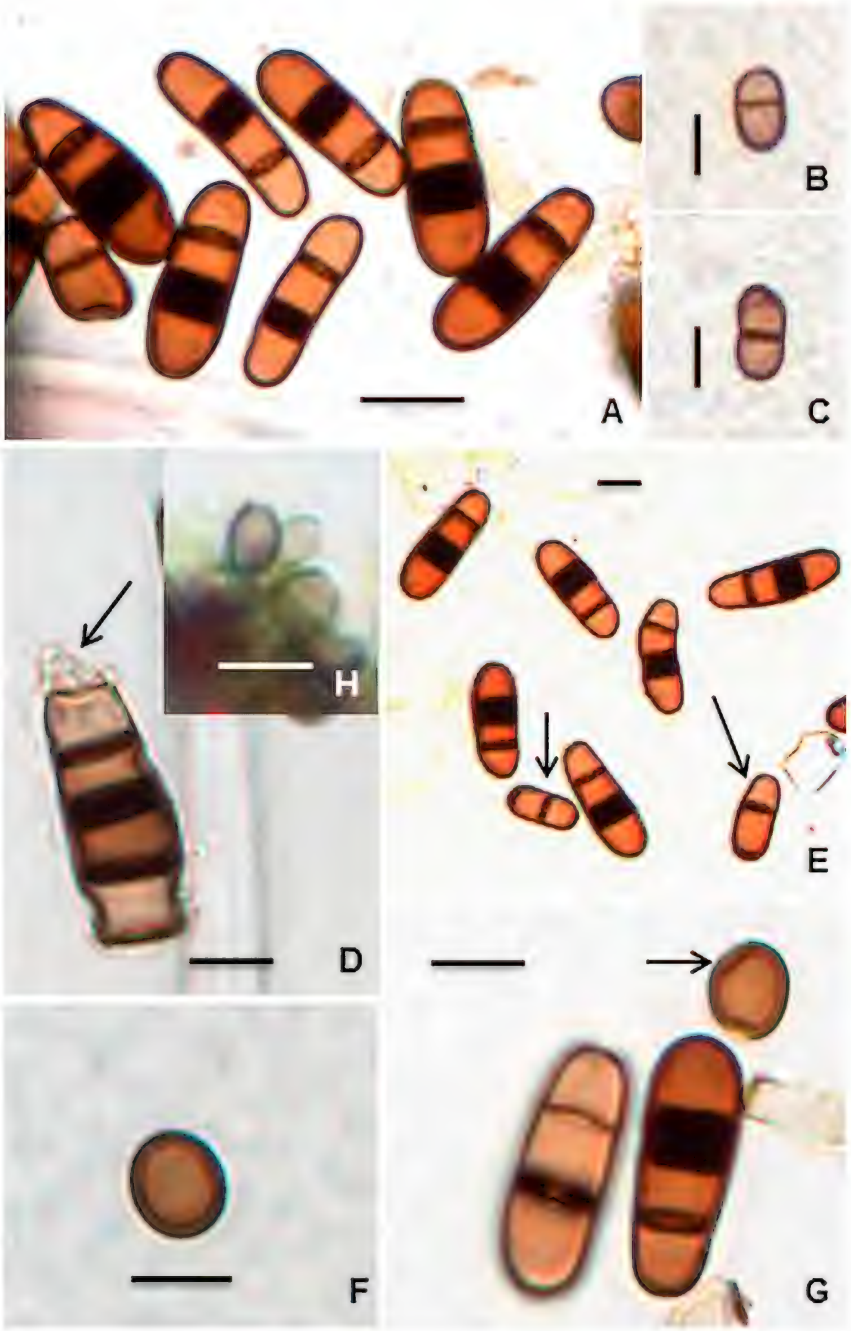
NOTE: There is a pore visible in the center of each septum and at the basal end of a conidium. The conidial forms used in this paper follow the six conidial forms categorized by Constantinescu & Samson (1982). In *Triadelphia acericola,* conidia of form (a) predominate, comprising over 90% of all conidia, with the three other forms (b, d, f) constituting <10%.

Very few intact conidiogenous cells were observed. It appeared that these conidiogenous cells collapsed once conidia became mature. Two apical cells of some mature conidia collapsed and even disintegrated, leaving only the basal cell. No intact form (d) conidia were present. Thus, the number of septa and size cited for form (d) conidia are approximations.

Conidiogenous cells were also not found in *T. inquinans,* presumably due to collapse. Hughes & Pirozynski (1973) and Ellis (1976) did not observe attached conidia or conidiogenous cells in the specimen of *T. inquinans* they studied. Hughes & Pirozynski (1973) assumed that the conidia of *T. inquinans* develop singly from swollen hyphal tips (subglobose conidiogenous cells?) that either collapse after or rupture during conidial secession.

Triadelphia acericola morphologically resembles *T. heterospora*, *T. inquinans*, and *T. diversa* in having 2-septate, cylindrical, form (a) conidia. *Triadelphia heterospora* differs by its much larger form (a) conidia (16.2–19.0 × 3.5–6.0 µm; Shearer & Crane 1971) and the absence of form (b); *T. diversa* form (a) conidia differ in their colorless basal cells (Tzean & Chen 1989); and *T. inquinans* form (a) conidia differ by the absence of any dark band covering the apical conidial septum (Hughes & Pirozynski 1973).

FIG. 1—*Triadelphia acericola* (holotype, BPI 893194). A. form (a) cylindrical conidia; B, C. form (b) oblong and ellipsoidal conidia; D. form (d) clavate conidia [arrow indicates collapsed terminal cell]; E. form (a) conidia with form (b) conidia [arrowed]; F. form (f) globose conidium; G. form (a) conidia with form (f) conidium [arrowed]; H. conidiogenous cells. Scale bars = 5 µm.


A
B
C
D
E
F
G
H

Despite several attempts to isolate this fungus onto cultural media, the fungus failed to grow on either MEA or CMA, suggesting that the fungus on the specimen may have lost its viability. Failure to isolate this fungus prevented us from obtaining DNA sequences and carrying out phylogenetic studies.

Triadelphia alabamensis (Matsush.) Constant. & Samson, Mycotaxon 15: 482. 1982 FIG. 2B

≡ *Stemphyliomma alabamensis* Matsush., Matsush. Mycol. Mem. 2: 16. 1981.

≡ *Pithomyces alabamensis* (Matsush.) P.M. Kirk, Trans. Br. Mycol. Soc. 80(3): 462. 1983.

This species develops two different conidial forms: form (d) fusiform or ellipsoidal, 6–8-septate, 28–44 × 10.5–16 μm; end cells colorless or pale brown, central cells pale brown to brown, dark band covering over the central septum; form (e) cylindrical, pale olivaceous, 1–3-septate (mostly 1-septate), smooth, curved, guttulate, with rounded ends, 14–28 × 4.5–5.5 μm.

HABITAT/HOST: On slime flux from wood of *Quercus*.

DISTRIBUTION: USA (Alabama).

Pithomyces alabamensis is now accepted as the current name of this species (MycoBank 2017, Species Fungorum 2017). Although its form (e) conidia do exhibit the rhexolytic secession of *Pithomyces,* its pleomorphic nature makes *Triadelphia* a better fit.

Triadelphia archontophoenicicola D.W. Li, **nom. nov.** FIG. 2C

MYCOBANK MB 813055

≡ *Triadelphia australiensis* Joanne E. Taylor, K.D. Hyde & E.B.G. Jones, Fungal Diversity Res. Ser. 12: 366. 2003, nom. illeg. (non B. Sutton 1989).

ETYMOLOGY: after the genus of *Archontophoenix alexandrae* (F. Muell.) H. Wendl. & Drude (*Arecaceae*) on which the type was collected.

A replacement name (nom. nov.) is required because *T. australiensis* Joanne E. Taylor et al. is an illegitimate later homonym of *T. australiensis* B. Sutton (McNeill et al. 2012: Art. 53.1).

This fungus develops five conidial forms and two types of conidiophores. Type 1 conidiophores are micronematous, cylindrical, flask-shaped, 18–30 × 8–12.4 μm, pale to dark brown, 1–3-septate; they bear form (d) conidia, obclavate, 104–132 × 19–24 μm, dark brown to black, abruptly becoming colorless at the long narrow apex, 5–9 μm wide, smooth, 10–13 septa, septa in dark part covered in dark bands. Type 2 conidiophores are semi-macronematous, cylindrical, 60–190 × 4–6 μm, dark red-brown, 4–8-septate; they develop form (a) conidia, cylindrical to fusiform, 24–35 ×

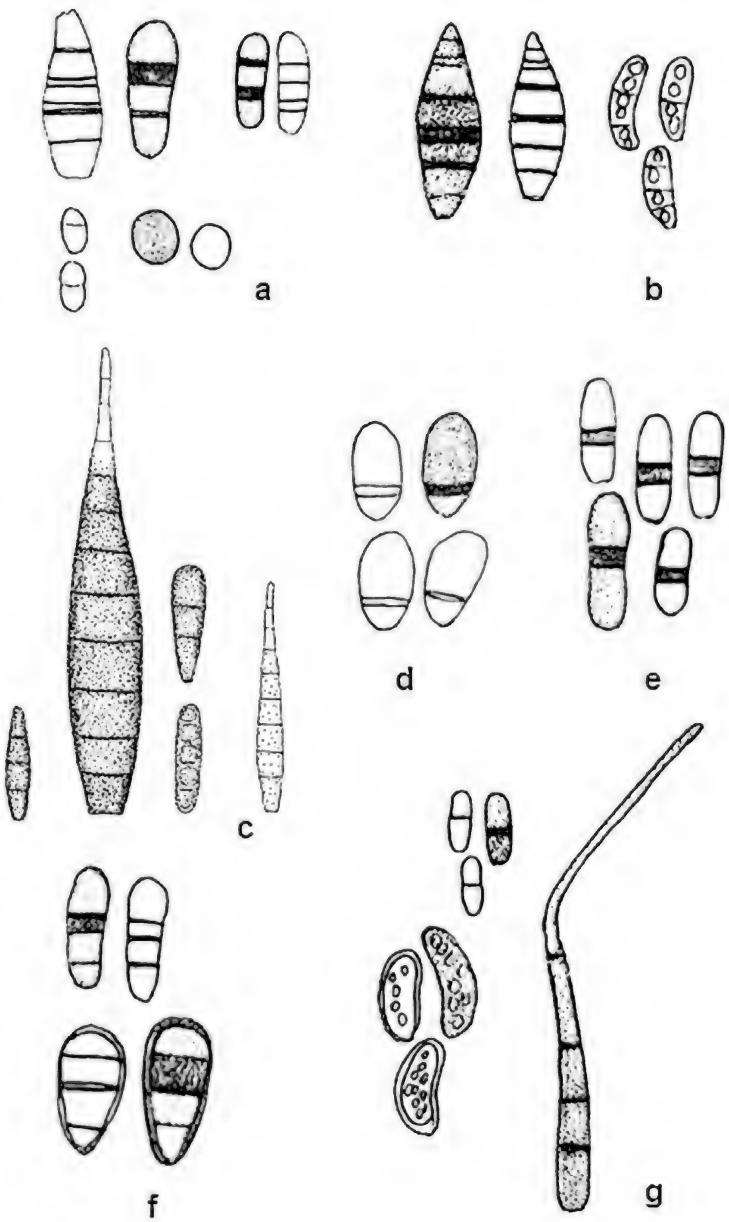


FIG. 2—Conidial forms produced by 7 *Triadelphia* spp.: a. *T. acericola*; b. *T. alabamensis*; c. *T. archontophoenicicola*; d. *T. australiensis* B. Sutton; e. *T. centroseptata*; f. *T. corticola*; g. *T. disseminata*. Line drawings by Rafael F. Castañeda-Ruiz.

6–9 µm, brown, 1–3-septate covered by narrow dark bands, smooth, with a conspicuous dark hilum, with or without a small mucilaginous appendage at the acute apex. In addition, conidial forms (b), (c), and (g) are associated with both conidiophore types: form (b) conidia, clavate, 24–26 × 8–11 µm, brown, 1–3-septate covered by dark bands, smooth, guttulate; form (c) conidia, acicular with a long colorless apex, 44 × 6 µm, pale yellow-brown, approximately 8-septate, smooth, acute apex, guttulate; and form (g) conidia, ellipsoidal to cylindrical, 18 × 6 µm, pale brown, straight or curved, smooth, 4-pseudoseptate, obtuse apex and base, guttulate (Taylor & Hyde 2003).

Habitat/host: on a dead rachis of *Archontophoenix alexandrae*.

Distribution: Australia.

This is a species with some features that are unique in the genus; it is the only species that develops two kinds of conidiophores, and it produces pseudoseptate form (g) conidia that do not correspond with any of the conidial forms categorized by Constantinescu & Samson (1982). Taylor and Hyde (2003) considered that these pseudoseptate conidia represented a new conidial form for the genus when they assigned their new species to *Triadelphia*. Further studies on this species are needed to determine its phylogenetic relationship with other members of *Triadelphia* and allied genera.

Triadelphia australiensis B. Sutton, Sydowia 41: 339. 1989 Fig. 2d

This species develops only form (b) conidia, 8.5–10 × 4.5–6 µm (Sutton 1989), apical, solitary, dry, ellipsoidal, obovoid to broadly obovoid, smooth, thick-walled, 1-septate near the base, thickened, some constricted at the septum.

Habitats/hosts: bark, submerged wood, water damaged plywood from a rink, and dry wall indoors (Li et al. 2013).

Distribution: Australia, Canada, Hong Kong, USA.

Triadelphia australiensis is morphologically very similar to *T. uniseptata*. The difference is that *T. australiensis* B. Sutton has smaller conidia than *T. uniseptata,* which are larger (12.5–16 × 6.5–10.5 µm; Kirk 1983). Ranghoo & Hyde (1998) identified *Trichocladium uniseptatum* [≡ *Triadelphia uniseptata*] as the anamorph of their new genus and species, *Ascolacicola aquatica* Ranghoo & K.D. Hyde, but their conidial measurements (6.5–10 × 3.8–6.3 µm) match *T. australiensis*, rather than *T. uniseptata*. Moreover, Réblová (2013) designated this anamorph as merely "*Triadelphia*-like."

Triadelphia centroseptata Venkateshw., S.M. Reddy & S.R. Reddy ex D.W. Li, **sp. nov.** FIG. 2E

MYCOBANK MB 823119

"*Triadelphia centroseptata*" Venkateshw., S.M. Reddy & S.R. Reddy, Indian Phytopath. 49(4): 340. 1997 ["1996"], nom. inval. (ICN Arts 40.1, 40.6, 40.7).

TYPE: India, Andhra Pradesh, Warangal, Daharmassagar Village, on dead rachis of *Cocos nucifera* L. (*Arecaceae*), 22 Nov 1989 (**Holotype**, IMI 300593; **isotype**, KUMH HM50).

The species was invalidly published by Venkateshwarlu et al. (1997), because they presented two herbarium accessions (IMI 300593; KUMH HM50) but failed to nominate either of them as a type, failed to include the word "type" or an equivalent, and failed to nominate a single herbarium where the holotype was conserved (McNeill et al. 2012: Art. 40). Here we validate the species by designating IMI 30059 as its holotype.

One conidial form (a): cylindrical, 12.5–21 × 4–8.5 µm, brown, 1-septate, septum covered in a wide dark band, smooth.

HABITAT/HOST: On dead rachis of *Cocos nucifera* L.

DISTRIBUTION: India

NOTE—*Triadelphia centroseptata* is described and illustrated in detail by Venkateshwarlu et al. (1997). The type material of this species should be closely examined in the future to determine whether it truly develops only one form of conidia. Its conidia resemble those of *T. inquinans*. However, the latter species produces smaller cylindrical conidia (a) as well as four other conidial forms.

Triadelphia corticola Manohar., N.K. Rao & D.K. Agarwal, J. Mycopathol. Res. 39: 109. 2001. FIG. 2F

Manoharachary et al. (2001) identified two conidial forms: form (a) as narrowly cylindrical rounded at the apex, smooth, 18–21 × 4.5–5.2 µm, 2-septate, distal septum covered by a wide dark band, basal one narrow, dark brown; and form (b) as larger, ovoid, smooth, rounded at the apex, 2-septate, distal septum covered by a wide brownish to black band, 18–21 × 7–8.3 µm. However, based on the type illustration and conidial secession of the fungus, it appears that these two conidial "forms" represent a single conidial form that vary in conidial width, both of which we refer to in our key as form (a).

HABITAT/HOST: on bark of an unidentified plant.

DISTRIBUTION: India.

Triadelphia corticola is morphologically similar to *T. hungarica* in conidial size and shape. But, *T. hungarica* develops another conidial form with 6–7 septa (Révay 1987).

Triadelphia disseminata Madrid & J. Edathodu, Persoonia 34: 235. 2015. FIG. 2g

This is the second species isolated from human beings (Madrid et al. 2015). It develops three types of conidia in culture: form (a) (sub) cylindrical with obtuse ends, pale to dark brown, smooth, thick-walled, with 1 septum situated above the middle (occasionally 1-celled), often slightly constricted at the septum, 5–11 × 2.5–4 µm; form (c) obclavate to acicular, straight to slightly curved, colorless to pale olivaceous brown, smooth, thin-walled, 3–4-septate, 43–227 × 3–4 µm, with a truncate base and a cylindrical body gradually tapering into a long beak with an obtuse end; and form (e) reniform to allantoid, colorless to light brown, smooth, thin-walled, 1-celled, with obtuse ends, 5.5–11.5 × 2–3.5 µm (Madrid et al. 2015).

HABITAT/HOST: from a disseminated infection in an immuno-compromised patient.

DISTRIBUTION: Saudi Arabia.

Triadelphia disseminata is morphologically similar to *T. pulvinata* The conidial form (c) of *T. disseminata* are 3–4-septate, while in *T. pulvinata* 5–7 septate (Maggi et al. 1978).

Triadelphia diversa Tzean & J.L. Chen, Mycologia 81: 630. 1989. FIG. 3A

This species develops five conidial forms: form (a), cylindrical, straight or slightly curved, 13.7–24 × 4–8 µm, 1–2-septate; septa covered with wide dark bands; wall smooth; apical and central cells brown, basal cell colorless or pale brown; form (b), broadly clavate, 11.5–15.3 × 6.3–8 µm, with one transverse septum near the base, covered with a dark band; smooth; apical cell brown, basal cell colorless or pale brown, with truncate base; form (d), obclavate, 4–6-septate, 15–26 × 6–7 µm; end cells colorless to pale brown, acicular, basal cells subhyaline to pale brown, truncate, central cells pale brown to brown, often with dark bands at the septa; form (e), allantoid or reniform, colorless or pale brown, 2 celled, smooth, thin-walled, 8–16 × 3–5 µm; and form (f), obovate, pale brown, 1-celled, smooth, 5.9–9.8 × 4.3–5.6 µm with a truncate base (Tzean & Chen 1989).

HABITAT/HOST: rotten fallen stem of angiosperm.

DISTRIBUTION: Taiwan.

Triadelphia diversa is morphologically similar to *T. acericola*, *T. heterospora*, and *T. inquinans*. *Triadelphia diversa* does not develop conidial form (c); *T. acericola* does not have conidial forms (c) and (e); *T. heterospora* has no

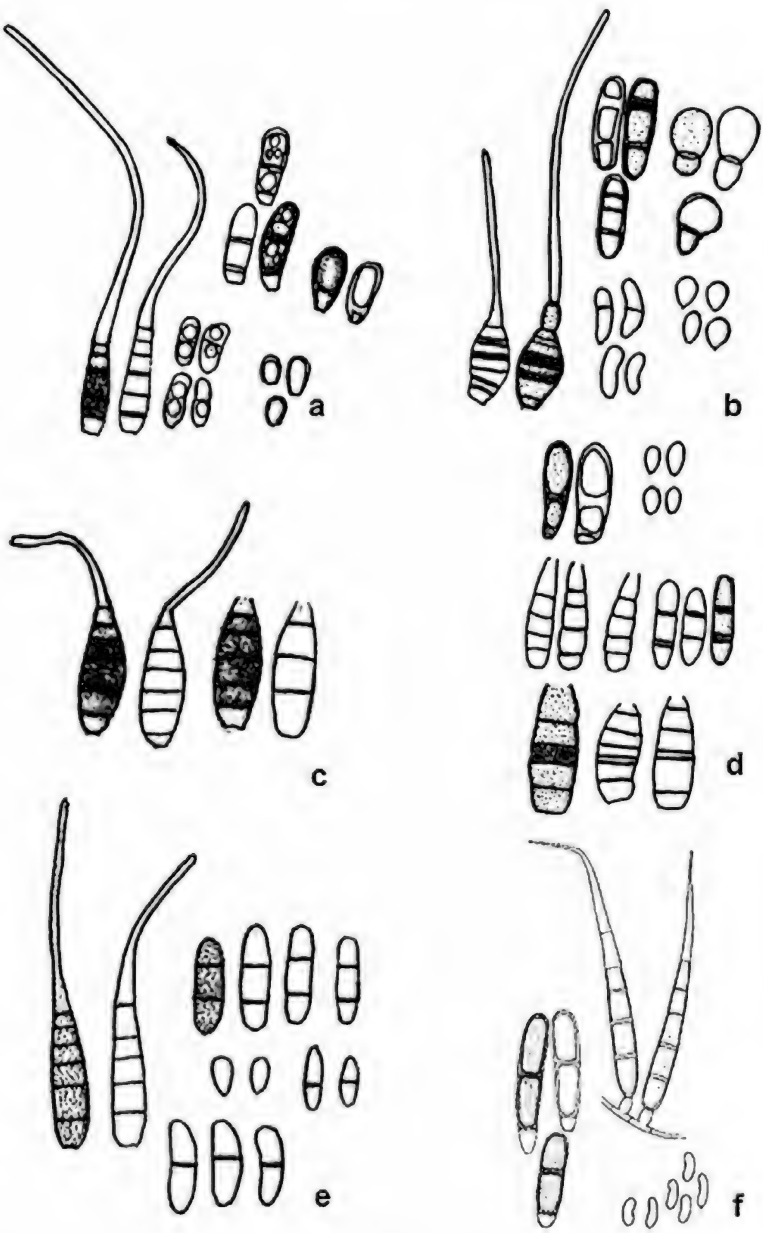


FIG. 3— Conidial forms produced by 6 *Triadelphia* spp.: a. *T. diversa*; b. *T. heterospora*; c. *T. hungarica*; d. *T. inquinans*; e. *T. loudetiae*; f. *T. morgoensis*. Line drawings a–e by Rafael F. Castañeda-Ruiz; line drawing f from Révay (1993), redrawn by the authors.

conidial forms (b) and (c) (Shearer & Crane 1971) and *T. inquinans*, no conidial form (e) (Hughes & Pirozynski 1973).

Triadelphia heterospora Shearer & J.L. Crane, Mycologia 63: 247. 1971. FIG. 3B

This is the type species of the genus *Triadelphia*. Shearer & Crane (1971) originally described *T. heterospora* as having two conidial forms: form (a), cylindrical, 2-septate, rounded at the apex, rounded to slightly truncate at base, brown, smooth, thick-walled, (14.7–)16.2–19.0(–21.2) × 3.5–6.0 μm, the apical septum covered by a black band and form (d), broad ellipsoid, 4–7-septate, 17.6–23.5 × 8.2–10.6 μm, end cells colorless to subhyaline, central cells subhyaline, brown to very dark brown often with black bands at the septa. After examination of the type material, Constantinescu & Samson (1982) described two additional conidial forms for this species: form (e), allantoid or reniform, colorless or pale brown, 0–1 septate, smooth, thin-walled, rounded at both ends, 8.5–15 × 3–5 μm and form (f), obovate to ellipsoidal, pale brown, 1-celled, smooth, thin-walled, 6–8 × 4–5 μm. However, their illustrations clearly showed that form (f) conidia were thick-walled. Shearer & Crane (1971) included "form (e)" conidia among cylindrical form (a) conidia in their illustration; it appears that they considered "form (e)" conidia to be merely immature cylindrical form (a) conidia.

HABITATS/HOSTS: balsa wood block submerged in fresh water, pine block submerged in sea water in the air, rain water, litter of *Mentha aquatic* L. and *Mentha* ×*rotundifolia* (L.) Huds. from wetland, and debris from a tree-hollow (Czeczuga et al. 2007, Gönczöl & Révay 2004, Révay 1987). This is an aquatic fungus, but it has also been found in the air of an orchid greenhouse (Magyar et al. 2011), and its cylindrical conidia were found in the air indoors in the USA (pers. obs.).

DISTRIBUTION: Cuba, Hong Kong, Hungary, India, Jamaica, Pakistan, Poland, USA.

Triadelphia heterospora is morphologically similar to *T. acericola*, *T. inquinans*, and *T. diversa*. *Triadelphia heterospora* does not develop conidial forms (b) and (c) (Shearer & Crane 1971); *T. acericola* does not have conidial forms (c) and (e); and *T. inquinans*, no conidial form (e) (Hughes & Pirozynski 1973); *T. diversa* does not develop conidial form (c) (Tzean & Chen 1989).

Triadelphia hungarica Révay, Acta Bot. Hung. 33: 68. 1987. FIG. 3C

This species develops two conidial forms: form (a), clavate or slightly cylindrical, dark brown, 2-septate with apical septum covered by a dark band,

17.6–20.8 × 6.4–7 µm and form (b), fusiform-ellipsoidal, straight or slightly curved, 6–7-septate, with a dark band in the middle, truncate at the base, 32–36 × 8–10 µm, central cells pale brown to dark brown (Révay 1987).

HABITAT/HOST: on debris of ?*Quercus*.

DISTRIBUTION: Hungary

Triadelphia inquinans (Sacc.) S. Hughes & Piroz.,
Can. J. Bot. 50: 2524. 1973 ["1972"]. FIG. 3D
≡ *Dicoccum inquinans* Sacc., Michelia 1(2): 264. 1878.

This species develops five conidial forms. Saccardo (1878) originally described only one type of conidia: form (b), cylindrical-clavate, 16–20 × 4–5 µm, 1-septate at middle, with rounded apex and truncate base. Hughes & Pirozynski (1973) and Ellis (1976) described form (b) and form (d) conidia.

Hughes & Pirozynski (1973) re-described this species based on their study of three specimens including the type. They described two conidial forms: form (b) conidia, shorter than those of the type, clavate, with thin-walled frill (part of conidiogenous cell?), 12–18 × 4–6 µm and form (d) conidia, broadly ellipsoidal, usually curved, 15–18 × 8–9 µm, possibly 5-septate (incomplete), the two middle cells thick-walled, dark brown with the median septum covered by a dark chestnut-brown band, the penultimate cells paler, and the end cells colorless to subhyaline.

Constantinescu & Samson (1982) studied the type material and described three additional conidial forms: form (a), cylindrical, (1–)2-septate, pale brown, smooth, 12–16 × 3–4 µm; form (c), obclavate, 3–5-septate, yellowing brown, smooth, thin-walled, tip not observed, the base truncate, 13–23 (incomplete) × 4–5 µm; and form (f), obovate to large ellipsoidal, pale brown, 1-celled, pale brown, smooth, thin-walled, 4–5 × 2.5–3 µm. However, the illustration of Constantinescu & Samson (1982) depict form (f) conidia as thick-, not thin-, walled; and form (d) conidia as larger (17–24 × 7–9 µm, [incomplete]) than those of Hughes & Pirozynski (1973).

HABITAT/HOST: decayed inner bark of *Populus nigra* var. *italica* Münchh., *Populus* sp.

DISTRIBUTION: Italy.

Triadelphia loudetiae Maggi, Bartoli & Rambelli,
Trans. Br. Mycol. Soc. 71: 150. 1978. FIG. 3E

Maggi et al. (1978) described only the predominant form (a) conidia: cylindrical, dark brown, 2-septate, rounded at both ends, smooth, a basal pore visible, 12–18 × 4.5–5 pm. Constantinescu & Samson (1982) included two

additional forms: form (c), obclavate, yellowish brown, sometimes slightly constricted at septa, smooth, thin-walled, 5–6-septate, 30–105 × 4–5 μm, gradually tapering into a long colorless beak and form (e), allantoid, reniform or nearly cylindrical, colorless or subhyaline, 0–1-septate, smooth, thin-walled, 7–12.5 × 2–3.5 μm.

HABITAT/HOST: from rhizosphere of *Loudetia simplex* (Nees) C.E. Hubb.

DISTRIBUTION: Ivory Coast.

Triadelphia morgoensis Révay, Stud. Bot. Hung. 23: 63. 1993 ["1992"]. FIG. 3F

This species develops three conidial forms: form (a), cylindrical, straight or slightly curved, 2-septate, thick-walled, with a rounded apex and a truncate base, 16–25.6 × 3.2–4.8 μm; form (c), obclavate, subhyaline, 5–7-septate, base truncate, gradually tapering into a long beak, 40–57.6 × 3.2–4 μm; and form (e), allantoid or reniform, colorless, one-celled, smooth, thin-walled, 4.8–6 × 2–3 μm (Révay 1993).

HABITAT/HOST: on rotten wood.

DISTRIBUTION: Hungary.

Triadelphia morgoensis differs from *T. diversa* by the absence of conidial forms (b), (d), and (f), by its narrower form (a) conidia having wide dark bands covering their septa (cf. *T. diversa* form (a) conidia, 13.7–24 × 4–8 μm, without dark bands), and by its 0-septate form (e) conidia (cf. 1-septate in *T. diversa*).

Triadelphia pulvinata Maggi, Bartoli & Rambelli,
Trans. Br. Mycol. Soc. 71: 150. 1978. FIG. 4A

Maggi et al. (1978) described the predominant form (a) conidia as solitary, cylindrical, deep brown, 1-septate, rounded at both ends, with distinct and smooth wall, basal pore not easily seen, 11.5 × 4 pm. Constantinescu & Samson (1982) described all three conidial forms for this species: form (a), cylindrical, pale brown, 1-septate, rounded at both ends, smooth, wall 0.3 μm thick, 9–12 × 3–3.4 μm; form (c), acicular to obclavate, colorless, slightly curved, smooth, thin-walled, 5–7 septate, 40–160 × 3–4 μm, gradually tapering into a long tail with rounded apex and truncate base; and form (e), allantoid or reniform, colorless or pale brown, 1-celled, smooth, thin-walled, rounded at both ends, 6–9.5 × 2–3 μm. Some conidia are mostly clavate, asymmetrical, dark brown, larger, 9–13 × 4.5–6 μm; Constantinescu & Samson (1982) considered these to represent over-mature form (e) conidia.

HABITATS/HOSTS: from rhizosphere of *Loudetia simplex*, dead rachides of *Phoenix canariensis* Chabaud (von Arx 1985), and a human eyelid infection.

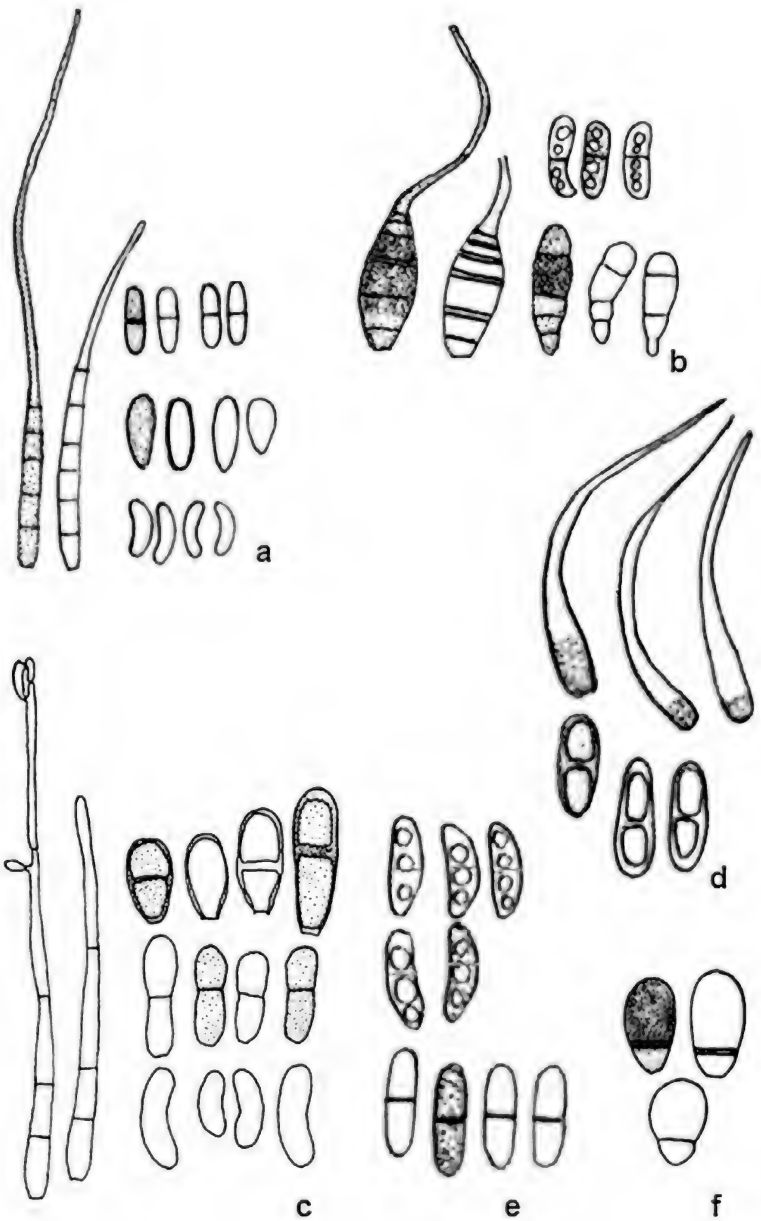


FIG. 4— Conidial forms produced by 6 *Triadelphia* spp.: a. *T. pulvinata*; b. *T. queenslandica*; c. *T. romanica*; d. *T. stilboidea*; e. *T. synnematofera*; f. *T. uniseptata*. Line drawings by Rafael F. Castañeda-Ruiz.

Triadelphia pulvinata is a soil hyphomycete that was reported to cause eczematoid, scaly, grey lesions on the skin of both eyelids of a male patient in Saudi Arabia (Al-Hedaithy 2001).

Distribution: Canary Islands, Ivory Coast, Saudi Arabia.

Triadelphia pulvinata was originally described with the conidia and conidiogenous cells developing on ropes of brown hyphae. This raises questions of whether these hyphal ropes are premature stages of synnemata or whether this species is intermediate between synnematous and semi-macronematous members of the genus. Further studies on this species are necessary.

T. pulvinata is morphologically similar to *T. romanica, T. stilboidea,* and *T. synnematofera*. Both *T. stilboidea*, and *T. synnematofera* develop synnemata (Mercado Sierra & Castañeda 1983, Matsushima 1995), while *T. pulvinata* and *T. romanica* do not. *Triadelphia pulvinata* does not develop conidial forms (b) and (d) (Maggi et al. 1978), while *T. romanica* has no conidial form (d) (Constantinescu & Samson 1982).

Triadelphia queenslandica Matsush., Matsush. Mycol. Mem. 6: 42. 1989. Fig. 4B

This species develops three forms of conidia: form (b), clavate, 1–3-septate, 15–30 × 8–13 µm, apical cells; brown, paler towards the basal cell; form (d), fusiform, apices frequently filiform, conidia without apical portion 30–42 × 12–18 µm, 5–6-septate, central cells brown black, paler towards both ends, apical cell about 400 µm long, filiform, 0-septate, colorless, often collapsed at maturity; and form (e), allantoid to reniform, mostly 1-septate, rarely 2-septate, 16–25 × 5–8 µm, pale brown (Matsushima 1989).

Habitat/host: on rotten leaf of *Musa ×sapientum* L.

Distribution: Australia (Matsushima 1989, Photita et al. 2002)

Triadelphia queenslandica, which is morphologically similar to *T. heterospora* and *T. hungarica,* does not develop conidial forms (a) & (c), while *T. heterospora* lacks conidial forms (b) & (c) and *T. hungarica* does not develop conidial forms c–f. The conidial form (b) of *T. queenslandica* does resemble the chlamydospores produced by aerial mycelia of *Trichocladium opacum* (Corda) S. Hughes (Kendrick and Bhatt 1966, Matsushima 1989). However, conidial forms (d) & (e) of *T. queenslandica* separate it from *Tric. opacum*.

Triadelphia romanica Constant. & Samson, Mycotaxon 15: 482. 1982. Fig. 4C

This species develops four forms of conidia: form (a), cylindrical, 0–1-septate, constricted in the middle, pale brown, smooth, 6.5–14 × 2.5–4 µm; form (b), clavate, brown, smooth, thick-walled (0.5–0.8 µm thick), 1-septate, 13–22 ×

5.5–5 µm; form (c), obclavate to acicular, colorless, smooth, thin-walled, 2–4-septate, 50–80 × 3–4.5 µm, base truncate, gradually tapering into a long beak of 1–1.5 µm wide; and form (e), allantoid to reniform, colorless, 1-celled, thin-walled, smooth, rounded at both ends, 7–12 × 2–3 µm (Constantinescu & Samson 1982).

HABITATS/HOSTS: Isolated from avian eggshell; decayed frond of *Palmae* (Matsushima 2001).

DISTRIBUTION: Peru, Romania.

Triadelphia romanica is morphologically similar to *T. pulvinata*. *Triadelphia romanica* does not develop conidial form (d) (Constantinescu & Samson 1982), while. *T. pulvinata* has no conidial forms (b) and (d) (Maggi et al. 1978).

Triadelphia stilboidea Mercado & R.F. Castañeda,
Revista Jard. Bot. Nac., Univ. Habana 4(2): 68. 1983. FIG. 4D

This species has synnematous conidiophores, tretic conidiogenous cells, and two conidial forms; form (a) predominating: cylindrical, sometimes ellipsoidal or obclavate, olivaceous or brown olivaceous, 1-septate, rarely 0-septate, 7.5–15 × 2.4–4.7 µm; and form (?c), seta-like, very long, obclavate, rostrate, 1-celled, dark brown at the base, becoming paler towards apex, subhyaline at apex, 20–85 × 3.5–4.7 µm, tapering to 0.7–1 µm at apices. The seta-like conidia of this species do not fit any forms categorized by Constantinescu & Samson (1982).

HABITATS/HOSTS: decayed leaf of unknown palm; dead leaf petiole of *Roystonea regia* (Kunth) O.F. Cook.

DISTRIBUTION: Cuba, Puerto Rico.

Révay (1993), who considered *T. stilboidea* not closely related to *T. heterospora* and other species of *Triadelphia*, excluded it from *Triadelphia.*

Matsushima (1995) considered that the synnematous *Triadelphia stilboidea* has setae similar to those of *Trichurus spiralis* Hasselbr., not setae-like conidia as described by Mercado Sierra & Castañeda (1983).

Triadelphia stilboidea and *T. synnematofera* both develop synnemata (Mercado Sierra & Castañeda 1983, Matsushima 1995). *Triadelphia stilboidea* develops conidial forms (a) and (c) (Mercado Sierra & Castañeda 1983), while *T. synnematofera* has conidial form (a) and (e) (Matsushima 1995).

Triadelphia synnematofera Matsush.,
Matsush. Mycol. Mem. 8: 38. 1995, as "*synnematfera*" FIG. 4E

Synnemata solitary, gregarious, cylindrical, 210–350 µm in height. Conidia of two forms: form (a) cylindric-ellipsoidal, 1-septate, smooth, dark brown,

9–17 × 3.5–5 µm and form (e) allantoid, reniform or cylindrical, 1-septate, straight or slightly curved, smooth, colorless, 11–16 × 4–5.5 µm (Matsushima 1995).

Habitat/Host: on decayed petiole of palm

Distribution: Peru.

Triadelphia synnematofera is another synnematous species with two conidial forms. Its form (a) conidia that are 1-septate and have no dark band over the septum easily distinguish it from *T. stilboidea*.

Triadelphia uniseptata (Berk. & Broome) P.M. Kirk,
Trans. Br. Mycol. Soc. 80: 464. 1983. Fig. 4f

≡ *Sporidesmium uniseptatum* Berk. & Broome, Ann. Mag. Nat. Hist., Ser. 3, 3: 360. 1859.

≡ *Trichocladium uniseptatum* (Berk. & Broome) S. Hughes & Piroz., Can. J. Bot. 50(12): 2526. 1973 ["1972"].

= *Dicoccum apiosporum* Sacc., Nuovo G. Bot. Ital. 22: 71. 1915 (Hughes & Pirozynski 1972).

= *Polyschema bicellulare* Shearer, Mycotaxon 14(1): 91. 1982 (Kirk 1983).

This is another species that develops only one conidial form, form (e), obovoid, 1-septate, smooth, brown, apical cell much larger than the basal cell. *Triadelphia uniseptata* is morphologically similar to *T. australiensis* B. Sutton, but differs in its larger conidia, 12.5–16 × 6.5–10.5 µm (Kirk 1983).

Habitats/hosts: on dead wood, submerged wood, stems, or twigs; debris from a tree hollow, on bark of *Clematis vitalba* L., bark of *Melicoccus bijugatus* Jacq., dead bark of *Quercus rubra* L., cones of *Pinus halepensis* Mill., rotting wood of *Hedycarya arborea* J.R. Forst. & G. Forst., stem of *Rubus plicatus* Weihe & Nees, on twigs of *Platanus occidentalis* L., softwood label in greenhouse, dust from indoor environments, rain water (Berkeley & Broome 1859, Hughes & Pirozynski 1973, Kirk 1983, Matsushima 1987, Révay 1987).

Distribution: Canada, Cuba, France, Hong Kong, Hungary, India, Malta, New Zealand, UK, United States.

Key to species of *Triadelphia*

1. Conidia only one form and not synnematous 2
1. Conidia pleomorphic (2–5 forms) or synnematous 5
2. Conidia 1-septate 3
2. Conidia 2-septate, cylindrical or clavate, smooth, 18–21 × 4.5–8.3 µm ... *T. corticola*
3. Conidia 1-septate near the base, thickened, sometimes constricted at the septum, ellipsoidal, to broadly obovoid, smooth 4
3. Conidia 1-septate at middle, cylindrical, 12.5–21 × 4–8.5 µm ..... *T. centroseptata*

4. Conidia 8.5–10 × 4.5–6 µm ..... *T. australiensis* B. Sutton
4. Conidia 12.5–16 × 6.5–10.5 µm ..... *T. uniseptata*

5. Synnemata present 6
5. Synnemata absent 7

6. Conidia of 2 forms: one cylindrical and 1-septate; the other seta-like ... *T. stilboidea*
6. Conidia of 1 form: cylindrical and 1-septate ..... *T. synnematofera*

7. At least one conidial form is broadly obclavate, fusiform ellipsoidal, with black band at the septa 8
7. Not as above 16

8. Conidia fusiform-ellipsoidal, without acerose end cells ..... *T. alabamensis*
8. Conidia broadly obclavate or fusiform-ellipsoidal with acerose end cells 9

9. Cylindrical conidia absent 10
9. Cylindrical conidia present 12

10. Conidiophores of two types with 5 conidial forms ..... *T. archontophoenicicola*
10. Not as above 11

11. Conidia fusiform-ellipsoidal, 32–36 × 8–10 µm ..... *T. hungarica*
11. Conidia fusiform, 30–42 × 12–18 µm ..... *T. queenslandica*

12. Allantoid or reniform conidia absent 13
12. Allantoid or reniform conidia present 14

13. Cylindrical form (a) conidia 2-septate, apical septum covered with a dark band, 13.4–15.8 × 4.2–5.4 µm ..... *T. acericola*
13. Cylindrical form (a) conidia (1–)2-septate without dark band, pale brown, smooth, 12–16 × 3–4 µm ..... *T. inquinans*

14. Clavate conidia absent 15
14. Clavate conidia present, cylindrical form (a) conidia 13.7–24 × 4–8 µm, 1–2-septate; septa covered with dark 2 µm bands, with a colorless base cell *T. diversa*

15. (Sub)cylindrical form (a) conidia 1-septate, 5–11 × 2.5–4 µm ..... *T. disseminata*
15. Cylindrical form (a) conidia 16.2–19.0 × 3.5–6.0 µm, 2-septate, the apical septum covered by a black band ..... *T. heterospora*

16. Cylindrical form (a) conidia 1-septate 17
16. Cylindrical form (a) conidia 2-septate 18

17. Cylindrical conidia 6.5–14 × 2.5–4 µm; clavate conidia present ..... *T. romanica*
17. Cylindrical conidia 9–12 × 3–3.5 µm; clavate conidia absent ..... *T. pulvinata*

18. Cylindrical conidia brownish, 9–19 × 3–5 µm; reniform conidia 1-septate ..... *T. loudetiae*
18. Cells of the cylindrical conidia differently pigmented, 16–25.6 × 3.2–4.8 µm; reniform conidia 0-septate ..... *T. morgoensis*

Discussion

Ranghoo & Hyde (1998) reported that *Ascolacicola aquatica* had *T. uniseptata* as its anamorphic state; however, the conidial size that they reported (6.5–10 × 3.8–6.3 µm) corresponds with *T. australiensis* B. Sutton rather than *T. uniseptata*, and Réblová (2013) designated the anamorph as merely "*Triadelphia*-like". *Platytrachelon abietis* (Réblová) Réblová also develops two forms of anamorphs morphologically similar to the *Triadelphia*-like anamorph of *Ascolacicola aquatica* (Réblová 2013). Réblová & Seifert analyzed nc28S sequences of *Triadelphia uniseptata* from Canada and *Platytrachelon abietis*; no close relationship was confirmed, and the molecular data placed *T. uniseptata* in the *Hypocreomycetidae*, *Sordariomycetes* (Réblová & Seifert unpubl.).

These results suggest that *Triadelphia* is polyphyletic and its systematic placement remains unknown. Further phylogenetic studies are necessary.

Acknowledgments

The authors are very thankful to Dr. Rafael F. Castañeda-Ruiz and Dra. Gabriela Heredia for their critical review of the manuscript. The authors express their great gratitude to Dr. Rafael F. Castañeda-Ruiz for making the line drawings in Figures 2–4 for us. The authors are appreciative to Dr. Ágnes Révay (Hungarian Natural History Museum, Hungary), Dr. Donat Magyar (National Environmental Health Institute, Hungary), Zhihe Li, (McGill University, Canada), and Yale University Library for their assistance in obtaining literature otherwise not available to the authors. The authors are very grateful to Dr. James A. LaMondia (The Connecticut Agricultural Experiment Station) for his pre-submission review, Dr. Lorelei Norvell for her editorial review, and Dr. Shaun Pennycook for his nomenclatural review.

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MYCOTAXON

ISSN (print) 0093-4666 (online) 2154-8889 Mycotaxon, Ltd. ©2017

October–December 2017—Volume 132, pp. 745–757

https://doi.org/10.5248/132.745

Glischroderma Fuckel

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Abstract—*Glischroderma* and its type species *G. cinctum* are redescribed and illustrated with respect to their original description. Subsequent collections of the species show significant divergences, possibly distinct species, which should be investigated from fresh material. American collections referred by Korf to *Glischroderma* based on the presence of gel and similar conidiogenesis are shown to be distinct from *Glischroderma* in a number of characters, and a 1999 phylogenetic study has related that anamorph to *Pachyphlodes pfisteri*. *Glischroderma* is also distinguished from *Ostracoderma* by decisive characters.

Keywords—*Chromelosporium, Lycoperdellon,* peridium, *Pezizales*, pore

Introduction

In 1973, when describing the *Botrytis* and *Botrytis*-like genera of conidial fungi, Hennebert included *Ostracoderma* Fr. and *Glischroderma* Fuckel; both supposedly produced dichotomously branched *Chromelosporium*-like conidiogenous hyphae producing abundant one-celled simultaneous conidia on denticles, but contained inside a peridium similar to the peridium of some gasteromycetes, such as *Lycoperdon*. The interpretation of *Ostracoderma* by Juel (1920) and Hughes (1953, 1958) was corrected by transferring the non-peridiate species to *Chromelosporium* Corda, with *Ostracoderma* [*ostracos* = shell] remaining monotypic with the peridiate *O. pulvinatum* Fr. originally classified by Fries in the *Trichodermataceae*, close to the hyphomycetes. Although no type material is available for *Ostracoderma pulvinatum*, Hennebert (1973) regarded the peridiate genus *Lycoperdellon* Torrend as a possible synonym. The genus *Glischroderma* was kept separate

for taxa with verrucose spores, absent in *Lycoperdellon*, a character ignored by both Fries and Fuckel but noted by Rea (1913).

In 1994 Richard P. Korf and his mycology class collected a specimen in the valley of Lost Lodge in New York State referred to *Glischroderma* based on its abundant gel [*glischros* = viscous] and *Chromelosporium*-like conidiogenesis; a study of the collection was initiated shortly thereafter but unfortunately interrupted for a long time. My study of the Korf collections preserved in CUP herbarium, here presented with reference to the type material of *Glischroderma cinctum* from herb. G, is dedicated to Korf's memory.

Materials & methods

This study is based on the examination of herbarium specimens from the herbaria of the Botanical Garden of Genève, Switzerland (G); of the Department of Plant Pathology, Cornell University, Ithaca, NY, USA (CUP); and of the Botanic Garden, Meisse, Belgium (B). A 1960 Olympus FH microscope with positive low phase contrast objectives was used for the microscopic examinations.

Taxonomy

Glischroderma Fuckel, Jahrb. Nassauischen Vereins Naturk. 23–24: 34, 1870.

ORIGINAL DESCRIPTION: Peridium hemisphaericum, tenax, persistens, demum [at length] in centro irregulariter fissum, e floccis tenuissimis contextum, furfuraceo-villosum, basi mycelio tenuissimo cinctum, sporidiis concervatis, minutissimis, globosis, floccis destitutis [lacking hyphae] repletum.

Obs. Peridium in statu juvenili siccum, album, contextu fibroso, dein in centro ampliatum [enlarged, extended], argillaceum, annulo albo e peridio juvenili represso orto [born limited from the young peridium] circumdatum.

TYPE SPECIES: *Glischroderma cinctum* Fuckel

Glischroderma cinctum Fuckel, Jahrb. Nassauischen Vereins Naturk. 23–24: 35, 1870 PLATES 1, 2, 3B,C, 4B, 5A

ORIGINAL DESCRIPTION: 1. *G. cinctum* Fuck. F.rh. 162. – Peridio hemisphaerico, usque ad semiunciam diametro transversali, argillaceo, cum annulo albo fibroso cincto, ore destituto [lacking a pore], sed demum irregulariter in centro fisso, sporidiis globosis, uniguttulatis, ca. 4 Mikr. diam., argillaceo-rubellis. Tab. I. Fig. 18 a. Fung. Nat.magn. b. Sporid. [see PLATE 2A]

Ad verlassenen Köhlerstellen an Köhlenstückchen, sehr selten, im Herbst. Unweit der Arnsbacher Brücke, im Winkler Wald.

ETYMOLOGY; Greek *glischros* = Latin *tenax* = viscous, sticky, adherent, gripping.

CONIDIOMA peridiate, hemispherical, pulvinate, not constricted at the base when mature, ≤9 mm diam. as dried, larger when fresh and mature

("ampliatum"), arising from a limited ("represso") subiculum adherent to the charcoal substrate.

Subiculum white, giving rise to the young fruitbody (Fuckel) and exceeding by 1–2 mm the rind of the mature peridium, made of a network of hyaline septate branched hyphae, 3.5–5.5 µm diam., here and there up to 12 µm diam.

Peridium persistent but fragile and easily fissured, with no central pore ("ore destituto"), ocher-grey to argillaceous brown in color as dried, externally comprising densely interwoven sinuous, septate, hyaline hyphae, and internally comprising a lacunar network of right- or broadly angled branched septate hyaline hyphae, 3.5–5.5 µm diam. Peridium at first dry when young (Fuckel), becoming later sticky ("tenax") or glutinous. According to Fuckel, the peridium dehisces through an irregular split at the center ("irregulariter in centro fisso") with no central pore observed.

Conidiogenous hyphae internal, hyaline, septate, 2–6 µm diam., seen as small collapsed pieces on the dried material. The agglutination of the conidia around pieces of hyphae (a few bearing denticles) on the microscopic slide and the regular size of the conidia suggest a conidiogenesis similar to that of *Chromelosporium* on irregular repeatedly bifurcate, coralloid, branched hyphae that produce very abundant conidia borne more or less simultaneously on minute denticles remaining visible all along the hypha, after which the hyphae collapse and almost disappear ("floccis destitutis").

Conidia holoblastic, globose, 3.5–4.2 µm diam., hyaline, pale yellow cream in mass, often sticking together as initially produced, the wall 0.5 µm thick and minutely verrucose.

> Holotype specimen examined: Fuckel, Fungi rhenani 162, 1763 labelled by Fuckel: «N°162 Nassau's Flora - *Glischroderma cinctum Fuckel* - Natürl. Standort: *ad carboner* - Fundort: *Oestrika Wald* - Erscheint: *Aut.* (scripsit Fuckel) - Leopold Fuckel» [Plate 1A]. On an old fireplace on debris of charcoal, very rare, in autumn, near the bridge over the Arnsbach, in the Winkler Forest, (near Oestrich, Germany). Overlabeled in 1894 when incorporated into the Herbier Barbey-Boissier «*Ostracoderma pulvinatum* Fr (?) Peridium in stadio juvenili siccum, album, contextu fibrilloso, dein in centro ampliatum, tenuissimum, glabrum, argillaceum, cum annulo albo, e peridio juvenili represso orto, circumdatum. In sylvarum locis adustis, rarissime. Autumno. In sylva Hostrichiensi.» [Plate 1C], a conflation of Fuckel's separate published generic and specific descriptions of *Glischroderma cinctum* (in herb. G). The holotype specimen consists of fifty fruit bodies from 1.5 to 9 mm in diam., glued on a piece of cardboard from loose original material in charcoal debris and recently overwritten «Herbier (G), Fungi rhenani 162, *Ostracoderma pulvinatum* Fr.» [Plate 1B]. A small envelope containing charcoal debris and small pieces of the fungus is included.

Comments—The schema by Hennebert (1973, fig. 10) illustrating the fruit body of *Glischroderma cinctum* is misleading in that it reflects the more or

Plate 1. A–C. *Glischroderma cinctum* type material (in herb. G).

Plate 2. *Glischroderma cinctum*: A. Fuckel (1870, Plate 1, fig. 18): a. the fruit body, b. the spores; B–D fruit bodies of the type material, two in side view (showing the flattened position on a cushion of white mycelium on the black charcoal substrate) and five in top view (showing some extension of the white subiculum and absence of a pore in the peridium).

less pedunculate fruitbody as drawn by Malençon (1964, fig. 1.D) for a more mature fruitbody instead of the "broadly sessile" fruit body sitting on a limited white hyphal subiculum noted by Fuckel (1870) and Rea (1913).

Another divergence from Fuckel in Hennebert's (1973) schema is the presence of a "well defined central pore" based on the Rea (1913) and Malençon (1964) interpretations of *Glischroderma cinctum*; Fuckel denied the presence of a pore.

Glischroderma aff. *cinctum* PLATES 3A, 5B

Differs from *Glischroderma cinctum* by: (1) the dehiscence developing from a central darker circular zone, scarcely conspicuous, that delimits a star-shape splitting of the peridial wall to form the lips of a central pore; (2) the hyphal structure of the peridium seen *in siccum* lacking the compacted hyphal surface observed in the type of *G. cinctum* (PLATE 3B).

PERIDIUM made of a lacunar (crisscross) network of hyphae similar to the peridium internal context of the *G. cinctum* type specimen. SUBICULUM hyphae 3.5–6 µm diam., septate, loosely interwoven, branched at broad or right angles, sometimes at opposite sides and enlarged up to 12 µm at branching. CONIDIOGENOUS HYPHAE are 6–8 µm diam., branching more or less dichotomously or coralloid, producing conidia on conspicuous denticles all along their side. A *Chromelosporium*-like conidiogenesis is deduced of the typical branched agglutination of conidia on pieces of collapsed the hyphae. CONIDIA are holoblastic, globose, 3.5–4.2 µm diam., the walls thin and minutely verrucose showing 4 to 6 warts in cross section,

SPECIMEN EXAMINED: **BELGIUM, ST. HUBERTUS FOREST, Baconfoy:** as *Catastoma circumscissum* Berk. & M.A. on burnt ground between mosses under *Abies excelsa* [= *Picea abies*], Oct. 1912, Herb. E. Bommer & M. Rousseau, in herb. B, redetermined as *Glischroderma cinctum* by V. Demoulin, 1966.

COMMENTS—Malençon (1964) describes the formation of the central pore as observed in the above specimen. Fuckel describes his species as "ore destituto, sed demum irregulariter in centro fisso", lacking any apical pore but splitting irregularly in the center. None of the fruit bodies in the *G. cinctum* type material shows such a pore or darkened circular center that could become a pore at the center of the peridium. The stickiness of the peridium described by Fuckel as 'tenax' has been observed only by C. Rea on fresh collections in England, but not by G. Malençon in Morocco. Would that observation or the character itself be circumstantial?

Plate 3. A. ***Glischroderma* aff. *cinctum*** (herb. B, coll. M. Rousseau in Belgium) showing central apical pore; B, C. ***Glischroderma cinctum*** (type): hyphal structure of the peridium, the context (B) and the compact surface (C) not observed in *G.* aff. *cinctum.* (Scale bars: B, C = 5 µm)

Glischroderma aff. *cinctum* might represent a second species of *Glischroderma*. This possibility should be investigated from fresh collections and their DNA analysis.

Pachyphlodes pfisteri Tocci, M.E. Smith & Healy, Ascomycete.org. 7(6): 360, 2015.

ANAMORPH (MITOSPORIC STATE) PLATES 4A,C, 5C

MYCELIAL MAT not peridiate, flat, irregularly extended, ≤3.5 cm diam., not constricted at the edge, appressed at the substrate, entirely or partially covered of a translucent glutinous liquid gel.

MYCELIUM white, a net of loosely interwoven broad hyphae, 5.3–8.5 µm, (often ≤17.5 µm) wide, generally straight, branching at wide or right angles, septate, often fasciculate (synnematous) up to 20 mutually anastomosing hyphae, the fascicles of hyphae becoming erect, sporulating along their side, bending in the superficial gel layer, when drying forming a translucent shiny and somewhat rose orange pellicle or membrane, persistent and brittle, enclosing superficial loose and fasciculate hyphae and covering the entire surface or only a part of the hyphal mat.

CONIDIOGENOUS HYPHAE hyaline, septate, most often arising from the side of erect fasciculate hyphae (synnemata) branching at right angles repeatedly and shortly, branches soon bifurcating in a very irregular dichotomous or coralloid way, branches covered at maturity all along their length with abundant conidia born more or less simultaneously on minute 1 µm long denticles that remain visible of the hyphal cell after release of the conidia.

CONIDIA (mitospores) holoblastic, globose, hyaline, white to pale yellow in mass, 4.2–6.5(–8) µm diam., with a wall 0.5 µm thick and conspicuously verrucose all over.

HOLOTYPE: FH (MES-306); reference sequence, GenBank JN102474 (Healy et al. 2015).

SPECIMENS EXAMINED: **USA, NEW YORK STATE: Alpine**, at the north end of Lost Gorge (Hendershot Gulf), (1) CUP 62646, as *Glischroderma cinctum* Fckl. (in Korf's handwritten notes *Glischroderma ?cinctum)* on decaying wet leaves col. Mycology 319 Class, id. R.P. Korf, 14.IX.1994, (2) CUP 63540, as *Glischroderma americanum*, on rotten wood of birch, col. J. Haudenshield, id. RPK, 20.IX.1995, (3) CUP 63647, on wet leaves, col. RPK, Lizoň et al. id. RPK, 19.VIII.1997. **Ithaca**, Coy Glen, (4) south slope nr Elm St, CUP 62652, on soil, leaves, enmeshing debris, col. P. Lizoň, id. RPK 12.X.1994, (5) CUP 62653, on mossy log. col. P. Mullin, id. RPK, 12.X.1994 (one fruit body 13x25 mm), (6) CUP 62654, idem as CUP 62653. **Malloryville**, Eames Bog, (7) ½ way up north slope, CUP 62650, as *Glischroderma* n. sp., on leaves, col. id. RPK, 5.X.1994. GenBank sequence of anamorph AF133160 (Norman & Egger 1999), (8) ¼ way up north slope, CUP 62651, as *Glischroderma* n. sp., on leaves, twigs, pieces of bark and base of ferns, col. KT. Hodges, id. RPK, 5.X.1994 [PLATE 4A] sequenced AF133160 by Norman & Egger (1999). (9) CUP 63648, on wet wood, col. RPK, Lizon et al., id. RPK, 19.VIII.1997. (10) CUP 63695, on duff, col., id. RPK, 16.IX.1998. [All specimens, (8) excepted, were annotated by Rosanne Healy (8.VIII.2013) as having spores and hyphae similar to *Pachyphlodes (thyselli)*-mitospore mat.]

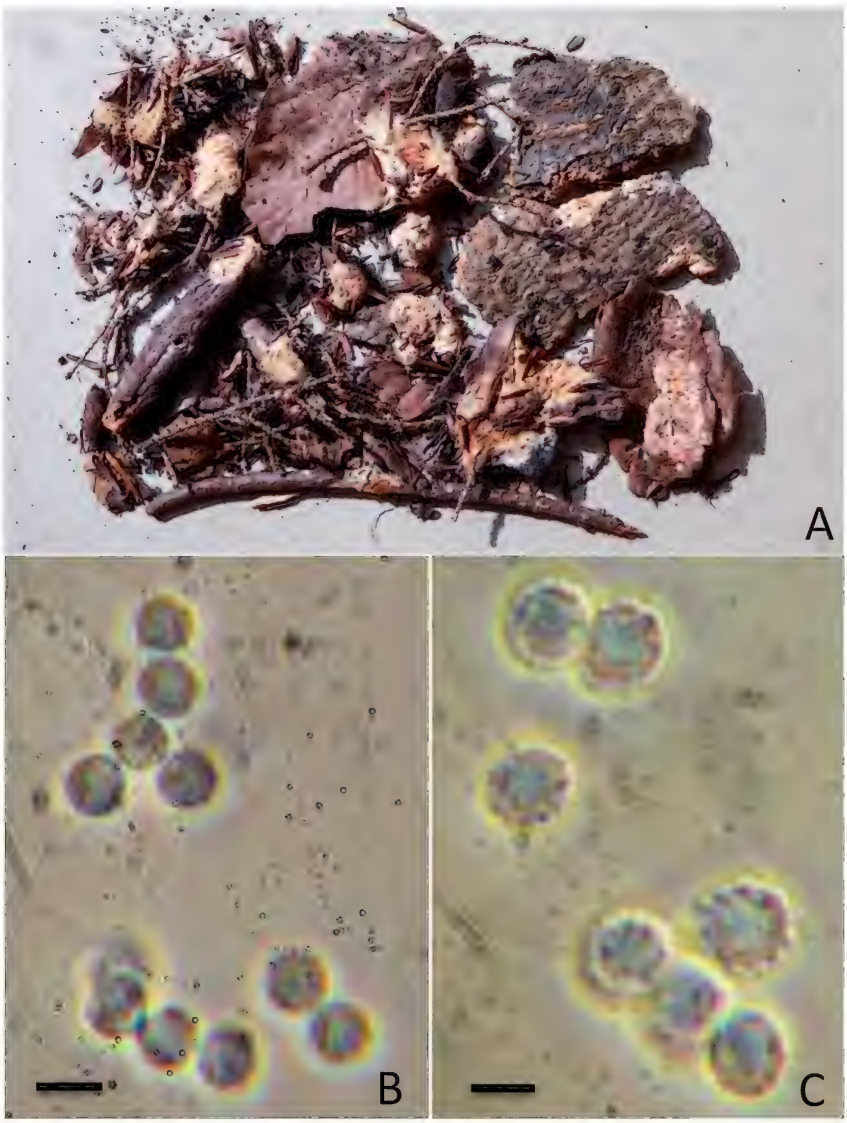

Plate 4. A. ***Pachyphlodes pfisteri*** (CUP 62651): epigeous anamorph of the truffle, coll. K.J. Hodges & R.P. Korf, NY State, USA; B. ***Glischroderma cinctum*** (type): conidia; C. ***Pachyphlodes pfisteri*** (type): conidia. (Scale bars: B, C = 5 μm)

Comments—*Pachyphlodes pfisteri* differs from *Glischroderma cinctum*, as Korf noted, by the natural substrate being not charcoal but rotting leaves, bark, and

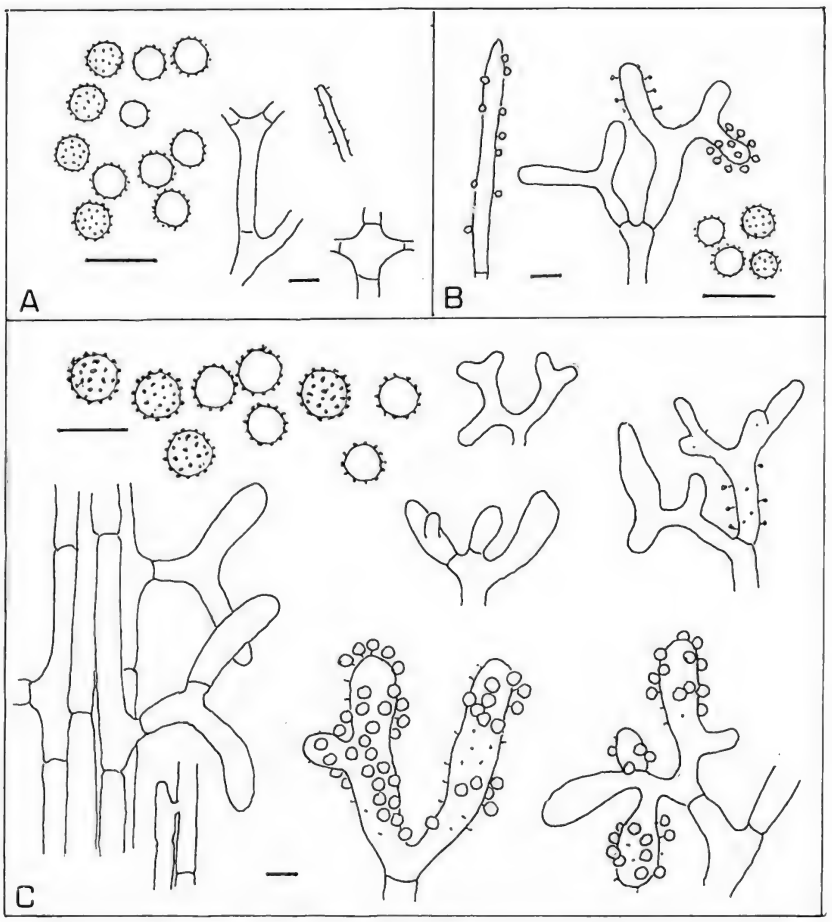

PLATE 5. A ***Glischroderma cinctum*** (type): branched hyphae, collapsed conidiogenous hypha with denticles, and conidia; B ***Glischroderma* aff. *cinctum*** (herb. Rousseau): conidiogenous hyphae and conidia. C. ***Pachyphlodes pfisteri*** (CUP 62646–62651, mitosporic state): conidiogenous synnema, conidiogenous hyphae, and conidia. (Scale bars = 10 μm)

twigs under beech or oak, mosses, or fern. Beyond its microscopic similarity in *Chromelosporium*-like conidiogenesis and verrucose conidia, the species might remind of *Glischroderma* by the gel encrusting the superficial hyphae into a translucent membrane suggesting a peridium. That membrane should not be called a peridium, an ontogenically distinct structure of hyphae born with and covering the entire fertile body (*peri* = all around); the ontogeny of the gel membrane distinguishes it from *Glischroderma*. For that reason, I do

not classify the *Pachyphlodes pfisteri* anamorph in *Glischroderma,* the name adopted by Korf (1994) and in CUP.

With its conidiogenous synnemata, *P. pfisteri* appears more closely related to the European *Chromelosporium terreste* (Fr.) M.B. Ellis.

Healy et al. (2015) published an illustrated description of the epigeous mitosporic mats of *Pachyphlodes pfisteri.* Another collection is illustrated here (Plate 4A, C).

Cultures, attempted by Korf, of broad hyphae on streptomycin CMA on 22 September 1994, grew rapidly, up to 2.5 cm in 10 days (Korf, handwritten notes). Conidia showed no sign of germination, as in some *Chromelosporium* species. For that reason, Healy et al. (2015) suggested that they might function as spermatia, germinating only in fertilizing ectomycorrhizal hypogeous hyphae.

The fresh collection of CUP material submitted by Korf for DNA analysis and published by Norman & Egger (1999), demonstrated a strong support for monophyly within *Pachyphloeus* and the *Scabropezia* clade in the *Pezizaceae*. This support was confirmed by Hansen et al. (2001), Tedersoo et al. (2006) and Læssøe & Hansen (2007). A refined phylogenetic study by Healy et al. (2013) of all known and undescribed taxa of *Pachyphloeus* Tul. & C. Tul., nom. illeg. [= *Pachyphlodes* Zobel] revealed the existence of 18 new taxa, two of which were fully described by Healy et al. (2015) as new species, *Pachyphlodes pfisteri* from North America and *P. nemoralis* from Europe.

Discussion

The classification of *Glischroderma* and *Ostracoderma* near *Chromelosporium* by Hennebert (1973) was based on the Malençon (1964) description of a Moroccan collection of *Glischroderma*. That observation on the genus *Glischroderma* incited Hennebert, also influenced by Juel (1920), to refer it to *Ostracoderma* and to synonymize *Lycoperdellon*, as no type existed for *Ostracoderma pulvinatum* and none of the terms of the original description suggested such interpretation.

Comparison of the original Latin descriptions (Table 1) clarifies the diagnosis. The only characters distinguishing *Glischroderma* from *Ostracoderma* are the circular hyphal subiculum and the viscosity of the mature fruit body, which justify the generic name and specific epithet (*cinctum*). The stickiness of fresh material observed by Fuckel was not seen by Fries.

Dried and with no traces of viscosity, the type material of *Glischroderma cinctum* could easily be identified as *Ostracoderma pulvinatum*, as has been done in herb. G, when no attention is drawn to the white circular subiculum

Table 1. Comparative descriptions of *Ostracoderma* and *Glischroderma*

Ostracoderma Fr. 1825 Type: *Ostracoderma pulvinatum* Fr. 1829	*Glischroderma* Fuckel 1870 Type: *Glischroderma cinctum* Fuckel 1870
Peridium	
Rotundatum, rotundato-hemisphaericum	hemisphaericum
crustaceum, crustosum	persistens
—	in juvenili siccum, [deinde glutinosum]
—	tenax,
glabrum, laeve, minime villosum	furfuraceo-villosum, e floccis tenuissimis contextum
fragile, fragillissimum	in centro irregulariter fissum
in medio fatiscens, collabens, evanescens	dein in centro ampliatum, ore destituto
albidum	albidum, dein argillaceum
tenue, tenuissimum, ½ unc.	semi unciam diametro
thallus nullus conspicuus	basi mycelio tenuissime cinctum, cum annulo albo fribroso cinctum, e peridio juvenili represso orto
Sporidia	
coacervata, laxa, laxe coacervata	coacervata
floccis nullis intertexta	floccis destitutis
globosa	globosa; uniguttulata
argillacea	argillaceo-rubellis
minuta	minutissima, ca. 4 Mik. diam.

(apparently denied by Fries's words "thallus nullus conspicuus").

The words 'fatiscens', 'collabens', 'evanescens' suggest that Fries observed the fungus living. Such observation does not match either any central irregular splitting in *Glischroderma cinctum* and in *Lycoperdellon torrendii* (Bres.) Torrend or any central star-shaped opening to form a pore in *Glischroderma* aff. *cinctum*. In light of these reflections, *Ostracoderma* remains a mystery and the earlier proposed synonymy of *Lycoperdellon* with *Ostracoderma* (Hennebert 1973) should be regarded now as tentative and even doubtful.

Acknowledgements

My gratitude is to Richard P. (Dick) Korf for his constant friendship, guidance, and support during 44 professional years and later. I met Dick for the first time in Ottawa in 1960. He invited us, Lidwina and me, to his home along the Lake in Ithaca, in the summer 1961. At his door, when we arrived, we found the message "Welcome, come in, the house is yours, we come very soon, Dick." Surprising! In September 1969, we discussed days and nights the nomenclature of the pleomorphic fungi for the Kananaskis First Conference, about my distinction between botanical and anatomical nomenclature. I was greatly honored when, as Fulbright Scholar in 1972–73, he chose to stay with us at the University of Louvain. From our joint wishes exchanged between September 2 and December 10, 1973 in Ithaca, Mycotaxon

was planned and then born in September 1974. And so our working friendship continued. Many thanks to You, Dick!

I am also grateful to Dr Philippe Clerc of the Herbarium (G), and to herbarium curators Dr Scott LaGreca (CUP) and Dr A. Bogaerts (B). My sincere thanks are for Prof. Dr Rosanne Healy (University of Florida) and Prof. Dr Kathie Hodges (Cornell University) for their collaboration and the scientific revision of the manuscript. The help of Dr Cony Decock of MUCL, and of Dr Lorelei Norvell and Dr Shaun Pennycook of Mycotaxon is also warmly acknowledged.

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MYCOTAXON

ISSN (print) 0093-4666 (online) 2154-8889 Mycotaxon, Ltd. ©2017

October–December 2017—Volume 132, pp. 759–766

https://doi.org/10.5248/132.759

Ellismarsporium gen. nov. and *Stanhughesiella* gen. nov. to accommodate atypical *Helminthosporium* and *Corynesporella* species

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Abstract—Two new genera are proposed: *Ellismarsporium* for species of *Helminthosporium* and *Corynesporella* that have catenate conidia and polytretic conidiogenous cells, and *Stanhughesiella* for a species of *Helminthosporium* with dictyoseptate conidia. Descriptions and illustrations are provided.

Key words—asexual ascomycota, hyphomycetes, taxonomy, tropical fungi

Introduction

Helminthosporium Link, typified by *H. velutinum* Link, is characterized by macronematous, unbranched, erect conidiophores. The conidiogenous

cells are polytretic, integrated, terminal and intercalary, determinate, with the conidiogenous loci at the apex and laterally below the septa. The conidia are solitary, obclavate to cylindrical-obclavate, distoseptate, sometimes rostrate, smooth, subhyaline to olivaceous brown, usually with an evident dark brown or brown basal scar.

Helminthosporium dictyoseptatum produces dictyoseptate conidia in polytretic conidiogenous cells (Hughes 1980). For this species, clearly separated from the *Helminthosporium* generic concept, we propose the new genus, *Stanhughesiella.*

Several other species with the same conidial ontogeny but producing blastocatenate conidia have been included in *Helminthosporium* (Bhat & Sutton 1985, Castañeda-Ruiz & Kendrick 1991, Ellis 1961, Matsushima 1975, Sutton 1993), requiring an expanded generic concept. A similar situation is found in *Corynesporella* Munjal & H.S. Gill [typified by *C. urticae* Munjal & H.S. Gill (Munjal & Gill, 1961)], which is diagnosed by macronematous conidiophores and monotretic, terminal or discrete conidiogenous cells that produce solitary or short catenate, distoseptate, subhyaline or pale brown conidia. In contrast, *Corynesporella pinarensis* and *C. simpliphora* are characterized by unbranched conidiophores and polytretic, integrated, intercalary and terminal conidiogenous cells that produce catenate distoseptate conidia (Castañeda-Ruiz 1985, Matsushima 1993)—characters that deviate from the *Corynesporella* generic concept. Consequently, we propose the new genus *Ellismarsporium* to accommodate these atypical *Helminthosporium* and *Corynesporella* species.

Taxonomy

Ellismarsporium R.F. Castañeda & X.G. Zhang, **gen. nov.**

MycoBank MB 807603

Differs from *Helminthosporium* by its acropetal, unbranched or branched chains of conidia and from *Corynesporella* by unbranched conidiophores and polytretic conidiogenous cells.

Type species: *Helminthosporium hypselodelphyos* M.B. Ellis [≡ *Ellismarsporium hypselodelphyos* (M.B. Ellis) R.F. Castañeda & X.G. Zhang]

Etymology: Latin, *Ellismar-sporium*, named in honor to Martin Beazor Ellis, (United Kingdom) for his contribution to the study of hyphomycetes + *-sporium*, referring to the conidia.

Colonies effuse, hairy, dark. Mycelium mostly immersed. Conidiophores distinct, single, unbranched, straight or flexuous, cylindrical or subulate, mid to very dark brown, smooth or verruculose. Conidiogenous cells polytretic, integrated, terminal and intercalary, determinate, cylindrical. Conidiogenous

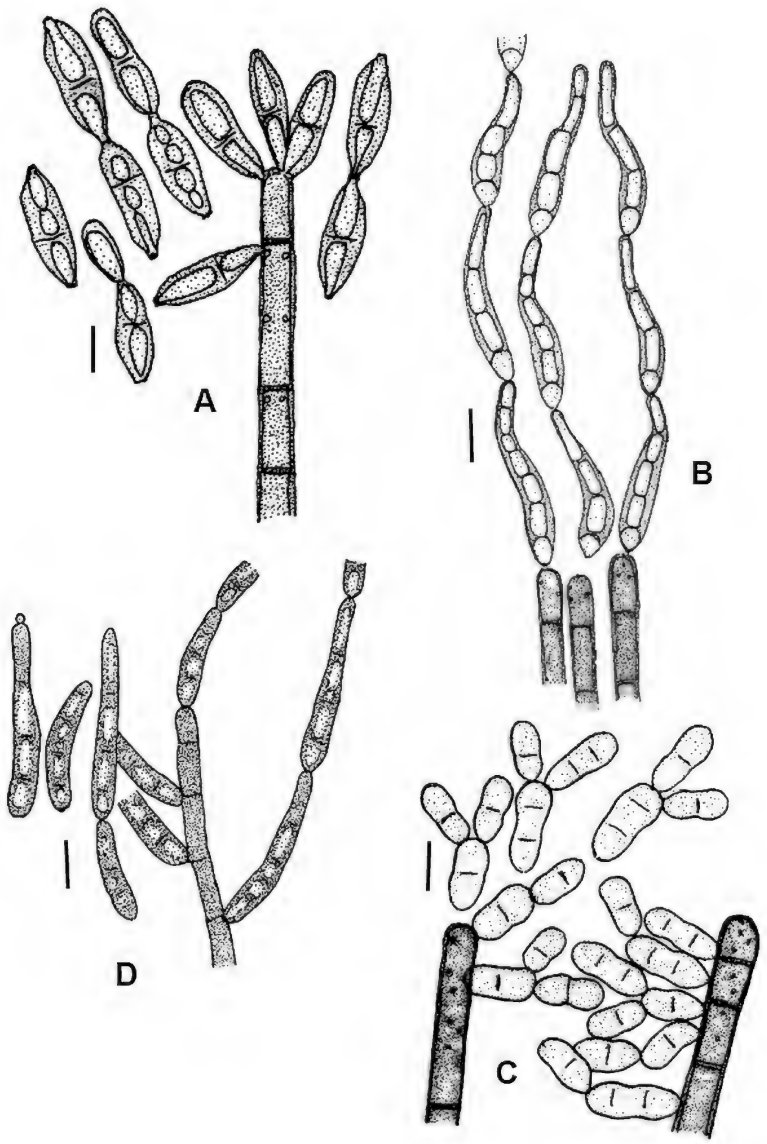

FIG. 1. *Ellismarsporium* species: conidiogenous cells and conidia. A. *E. hypselodelphyos* (Ellis 1961); B. *E. catenatum* (Matsushima 1975); C. *E. parvum* (Castañeda-Ruiz & Kendrick 1991); D. *E. pinarense* (Castañeda-Ruiz 1985). Scale bars: A, C, D = 10 µm; B = 20 µm. Redrawn by R.F. Castañeda-Ruíz.

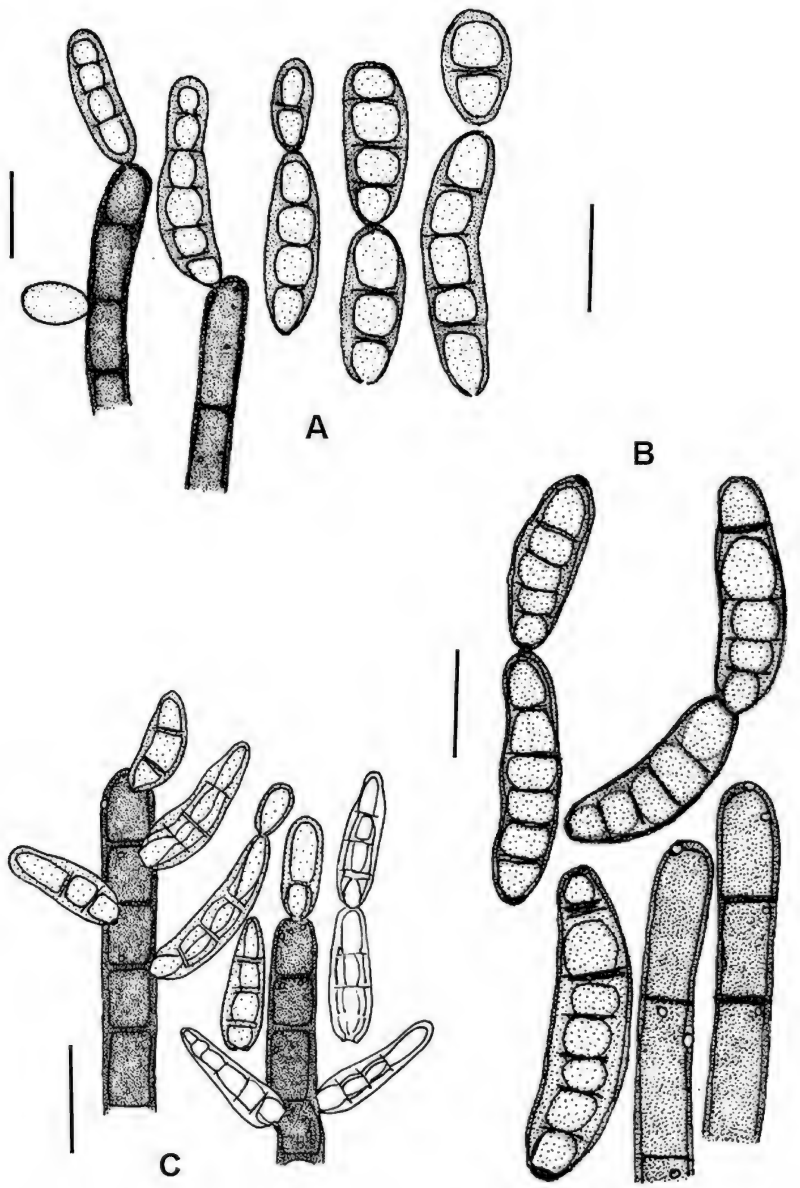

FIG. 2. *Ellismarsporium* species: conidiogenous cells and conidia. A. *E. senseletii* (Bhat & Sutton 1985); B. *E. simpliphorum* (Matsushima 1993); C. *E. zombaense* (Sutton 1993). Scale bars: A, B = 10 μm; C = 20 μm. Redrawn by R.F. Castañeda-Ruíz.

LOCI pores near septa. CONIDIA blastocatenulate, acropleurogenous, obclavate, cylindrical, ellipsoid to oblong, distoseptate, pale brown to brown, smooth or verruculose, sometimes with a dark brown or black scar at the ends.

Ellismarsporium hypselodelphyos (M.B. Ellis) R.F. Castañeda & X.G. Zhang, **comb. nov.** FIG. 1A

MYCOBANK MB 807604

≡ *Helminthosporium hypselodelphyos* M.B. Ellis, Mycol. Pap. 82: 18 (1961).

Ellismarsporium catenatum (Matsush.) R.F. Castañeda & X.G. Zhang, **comb. nov.** FIG. 1B

MYCOBANK MB 807605

≡ *Helminthosporium catenatum* Matsush., Icon. Microfung. Matsush. Lect.: 83 (1975).

Ellismarsporium parvum R.F. Castañeda & W.B. Kendr., **nom. nov.** FIG. 1C

MYCOBANK MB 807606

≡ *Helminthosporium parvum* R.F. Castañeda & W.B. Kendr., Univ. Waterloo Biol. Ser. 35: 57 (1991), nom. illeg. (non Grove 1886).

Ellismarsporium pinarense (R.F. Castañeda) R.F. Castañeda & X.G. Zhang, **comb. nov.** FIG. 1D

MYCOBANK MB 807607

≡ *Corynesporella pinarensis* R.F. Castañeda, Deuteromyc. Cuba, Hyphomyc. 3: 12 (1985).

Ellismarsporium senseletii (Bhat & B. Sutton) R.F. Castañeda & X.G. Zhang, **comb. nov.** FIG. 2A

MYCOBANK MB 807608

≡ *Helminthosporium senseletii* Bhat & B. Sutton, Trans. Brit. Mycol. Soc. 85: 119 (1985).

Ellismarsporium simpliphorum (Matsush.) R.F. Castañeda & X.G. Zhang, **comb. nov.** FIG. 2B

MYCOBANK MB 807609

≡ *Corynesporella simpliphora* Matsush., Matsush. Mycol. Mem. 7: 47 (1993).

Ellismarsporium zombaense (B. Sutton) R.F. Castañeda & X.G. Zhang, **comb. nov.** FIG. 2C

MYCOBANK MB 807610

≡ *Helminthosporium zombaense* B. Sutton, Mycol. Pap. 167: 32 (1993).

Key to *Ellismarsporium* species

1. Conidia not more than 3-distoseptate 2
1. Conidia more than 3-distoseptate 3
2. Conidia 1–2-distoseptate, cylindrical-ellipsoidal to oblong, slightly constricted at the middle, smooth, brown, 12–27 × 7–12 µm ..... *E. parvum*
2. Conidia 1–3-distoseptate, fusiform, clavate or oblong, smooth, pale olivaceous brown, 15–28 × 6.5–8 µm ..... *E. hypselodelphyos*

3. Conidia not more than 6-distoseptate 4
3. Conidia more than 6-distoseptate 6

4. Conidia 1–5-distoseptate, obclavate, smooth, brown to olivaceous brown, 25–75 × 3.5–7 µm ..... *E. pinarense*
4. Conidia not as above 5

5. Conidia 0–6-distoseptate, cylindrical to fusiform to obclavate, slightly constricted at the septa, smooth, mid brown, curved, 10–33 × 7.5 µm ..... *E. senseletii*
5. Conidia 2–6-distoseptate, obclavate, curved, smooth, pale olivaceous, 15–80 × 6–8.5 µm ..... *E. catenatum*

6. Conidia 1–7-distoseptate, obclavate to cylindrical, or long oblong, curved, pale olivaceous, with brown scar at the ends, 18–62 × 6.5–10 µm ..... *E. simpliphorum*
6. Conidia 3–5(–10)-distoseptate, obclavate, smooth, subhyaline, with a dark brown basal scar, 26–50(–74) × 7.5–9.5 µm ..... *E. zombaense*

Comments: *Helminthosporium velutinum*, *H. dalbergiae*, and *H. magnisporum* were found phylogenetically associated with the family *Massarinaceae* by Tanaka et al. (2015), but no molecular data were found on the seven proposed *Ellismarsporium* species; further molecular study is necessary in order to establish their phylogeny.

Stanhughesiella R.F. Castañeda & D.W. Li, **gen. nov.**

MycoBank MB 807614

Differs from *Helminthosporium* by its dictyoseptate conidia.

Type species: *Helminthosporium dictyoseptatum* S. Hughes [≡ *Stanhughesiella dictyoseptata* (S. Hughes) R.F. Castañeda & D.W. Li]

Etymology: Latin, *Stanhughesiella*, described in honor to Stanley J. Hughes (Canada) for his contribution to the studies of the hyphomycetes.

Colonies effuse, hairy, dark. Mycelium mostly immersed. Conidiophores distinct, single, unbranched, straight or flexuous, septate, cylindrical or clavate, mid to very dark brown, smooth or verruculose. Conidiogenous cells polytretic, integrated, terminal and intercalary, determinate. Conidia solitary, acropleurogenous, simple, obclavate, cylindrical to ellipsoid, dictyoseptate, pale brown to dark brown, smooth, sometimes with a dark brown or black scar at the base.

Stanhughesiella dictyoseptata (S. Hughes) R.F. Castañeda & D.W. Li, **comb. nov.** Fig. 3

MycoBank MB 807615

≡ *Helminthosporium dictyoseptatum* S. Hughes, New Zealand J. Bot. 18: 69 (1980).

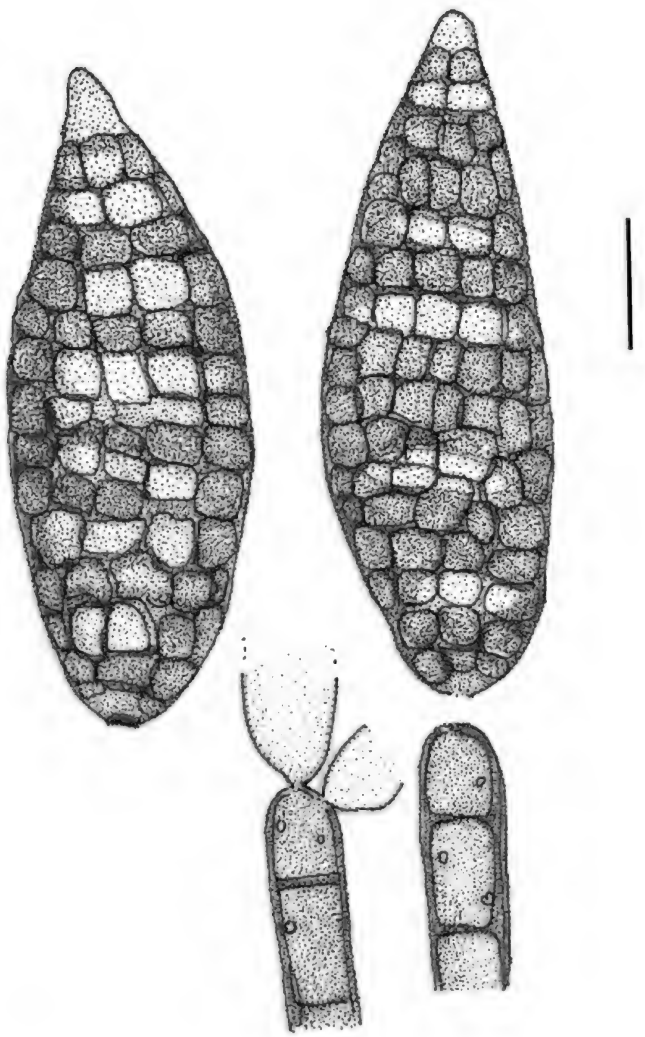

FIG. 3. *Stanhughesiella dictyoseptata*: conidiogenous cells and conidia (Hughes 1980). Scale bar = 10 µm. Redrawn by R.F. Castañeda-Ruíz.

COMMENTS: *Briansuttonia* R.F. Castañeda et al., *Embellisia* E.G. Simmons, *Gibbago* E.G. Simmons, and *Ulocladium* Preuss (Seifert et al. 2011) are superficially similar to *Stanhughesiella*, but those four genera have

cicatrized conidiogenous loci and some produce conidia in acropetal chains. *Stanhughesiella* also resembles *Stemphylium* Wallr. (Seifert et al. 2011), which is distinguished by monoblastic conidiogenous cells with a distinct cupulate cicatrized scar that develops after several enteroblastic percurrent regenerations.

Acknowledgments

We are indebted to Dr. Josiane S. Monteiro and Dr. Gabriela Heredia for critical review. RFCR and BRG are grateful to Organización Superior de Dirección Empresarial Grupo Agrícola (OSDE) from Cuban Ministry of Agriculture and Programa de Salud Animal y Vegetal (project P131LH003033). Dr. Lorelei L. Norvell's editorial review and Dr. Shaun Pennycook's nomenclature review are greatly appreciated.

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MYCOTAXON

ISSN (print) 0093-4666 (online) 2154-8889 Mycotaxon, Ltd. ©2017

October–December 2017—Volume 132, pp. 767–773

https://doi.org/10.5248/132.767

Endophragmiella jiulingensis sp. nov. and two new records from China

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Abstract—A new species, collected on dead branches of an unidentified broadleaf tree from southern China, is described and illustrated. *Endophragmiella jiulingensis* is distinguished by branched conidiophores producing cylindrical, smooth, 0-septate, 6–8 × 4.5–5.3 μm conidia. *Botryomonilia scheeleae* and *Camposporium ramosum* are newly recorded from China.

Key words—anamorphic fungi, taxonomy

Introduction

The genus *Endophragmiella* was erected by Sutton (1973) for two species, *E. pallescens* B. Sutton, the type species, and *E. canadensis* (Ellis & Everh.) B. Sutton. Subsequently, the genus was emended by Hughes (1979), who gave a very detailed account of conidiogenesis and generic concepts. *Endophragmiella* is mainly characterized by solitary acrogenous conidia seceding rhexolytically from monoblastic, integrated, terminal, determinate or percurrently extending conidiogenous cells (Sutton 1973, Ellis 1976, Hughes 1979, Wu & Zhuang 2005). At present, over 90 species are accepted in the genus (Ma et al. 2011, Ren et al. 2011, MycoBank 2017). All species within *Endophragmiella* are distinguished primarily by morphological differences in conidial characteristics, such as shape, size, pigmentation, septation, and presence or absence of a rostrum at the apex (Sutton 1973, Ellis 1976, Hughes 1979, Wu & Zhuang 2005).

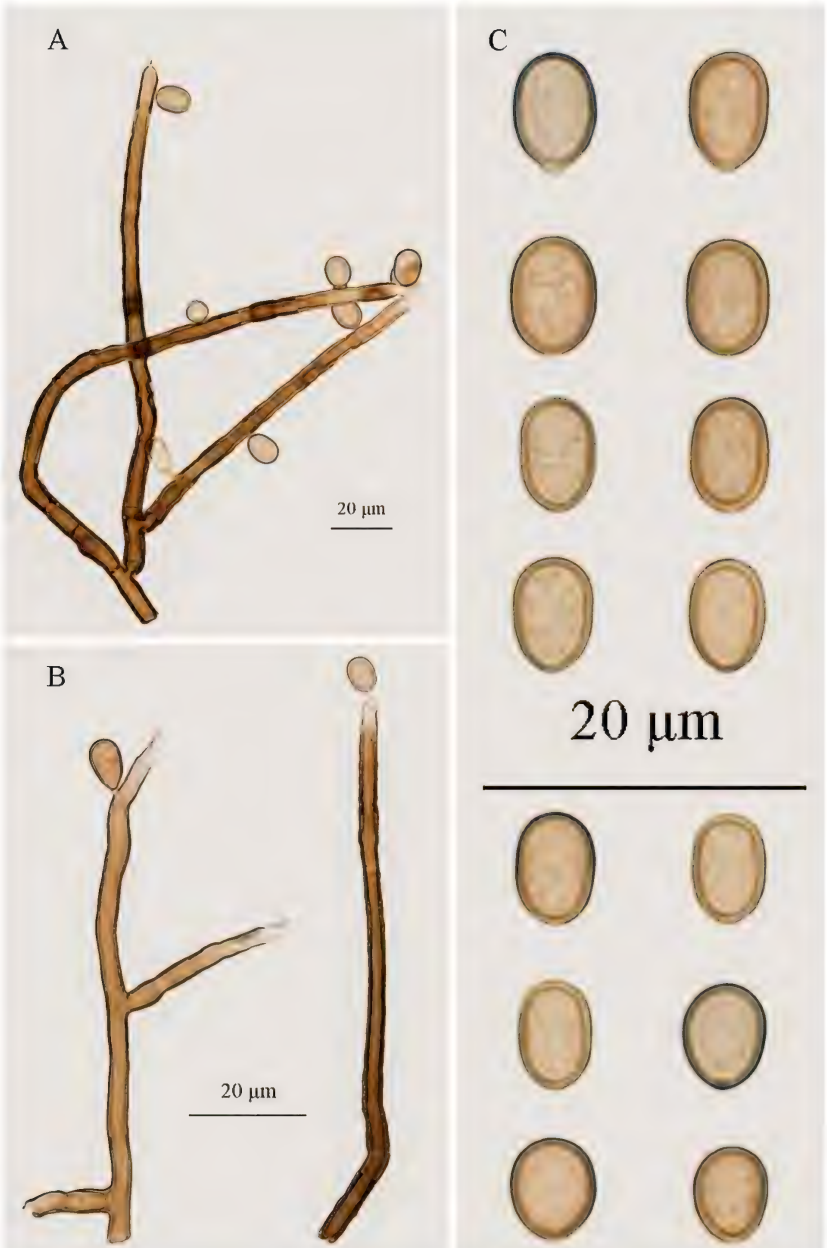

Fig. 1. *Endophragmiella jiulingensis* (holotype, HSAUP H7927). A, B. Conidiophores, conidiogenous cells, and conidia; C. Conidia.

During ongoing surveys of saprobic microfungi from forests of southern China, three interesting anamorphic species were collected from dead branches. One fungus represents an undescribed species of *Endophragmiella* B. Sutton, while the other two species are *Botryomonilia scheeleae* and *Camposporium ramosum*, both new records for China. The specimens are deposited in the Herbarium of Department of Plant Pathology, Shandong Agricultural University, Taian, Shandong, China (HSAUP) and the Mycological Herbarium, Institute of Microbiology, Chinese Academy of Sciences, Beijing, China (HMAS).

Endophragmiella jiulingensis H.H. Li & X.G. Zhang, **sp. nov.** FIG. 1

MycoBank MB 823127

Differs from *Endophragmiella corticola* by its smaller, 0-septate conidia.

TYPE: China, Jiangxi Province: Jiuling Mountain, on dead stems of an unidentified broadleaf tree, 8 Nov. 2016, C.L. Yang (**Holotype**, HSAUP H7927; **isotype**, HMAS 245643).

ETYMOLOGY: in reference to the type locality.

COLONIES on the natural substrate effuse, brown. Mycelium partly superficial, partly immersed, composed of branched, septate, pale brown to brown, smooth-walled hyphae. CONIDIOPHORES macronematous, mononematous, arising terminally and laterally from mycelium, erect, straight or flexuous, irregular branched, multiseptate, smooth, pale brown to brown, 88–187 × 2.9–7 µm. CONIDIOGENOUS CELLS integrated, terminal, percurrent, cylindrical, tapering to a truncate apex, pale brown, 16–29.5 × 2–3 µm. Conidial secession rhexolytic. CONIDIA solitary, acrogenous, cylindrical, 0-septate, smooth, pale brown to brown, 6–8 × 4.5–5.5 µm.

COMMENTS—*Endophragmiella jiulingensis* is similar to *E. corticola* P.M. Kirk in having branched conidiophores, but *E corticola* differs by its larger, multiseptate conidia (16–25 × 5.5–7.5 µm, 2–3-septate; Kirk 1982).

Botryomonilia scheeleae Goos & Piroz., Canad. J. Bot. 53: 2928, 1975. FIG. 2

COLONIES on the natural substratum effuse, brown, hairy. Mycelium superficial and immersed, simple or branched, dark yellow-brown hyphae. CONIDIOPHORE stalk ≤72 µm high and with ≤30 perforated septa, mostly 7.5–12.5 µm diam. but sometimes narrowed near the base or wider towards the tip; wall thin, roughened by fine to coarse vesicular inclusions, which are distributed evenly along the entire conidiophore length or limited to (or coarser along) only a part of it. At the apex the conidiophore dichotomously

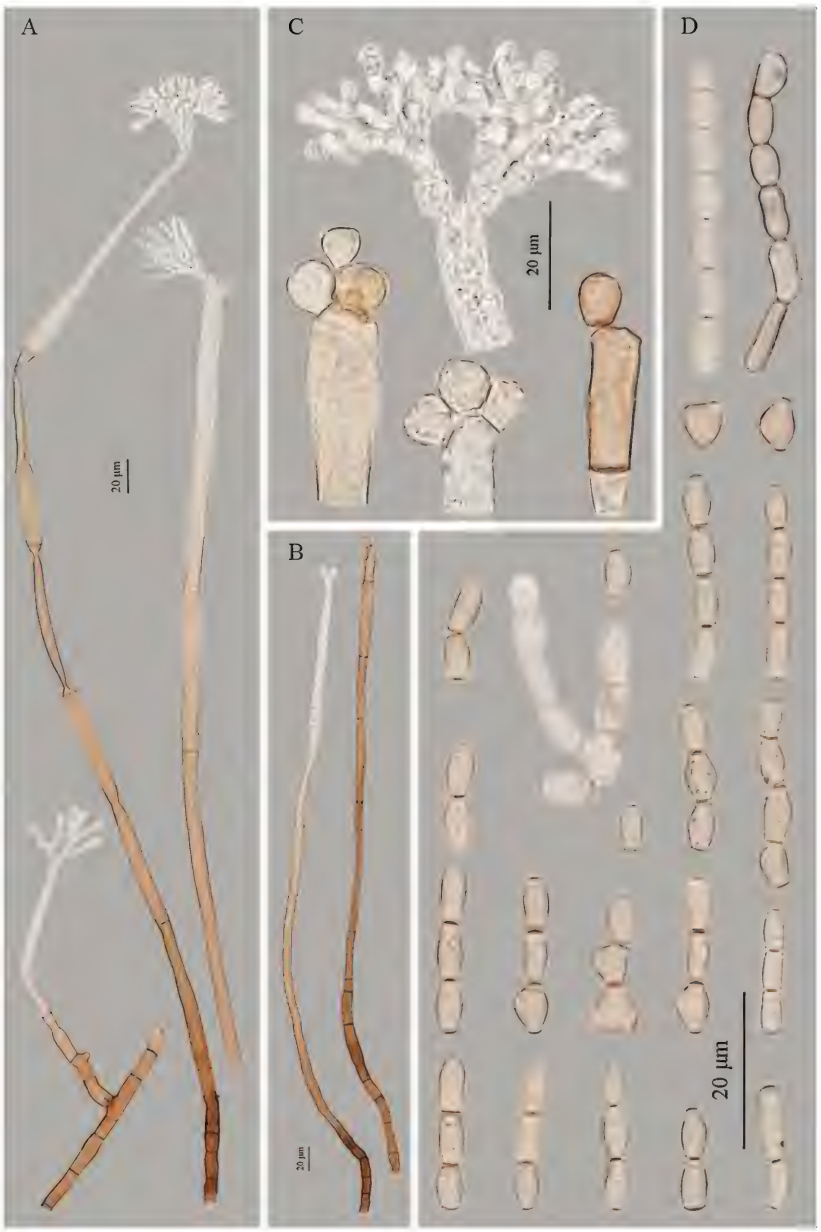

Fig. 2. *Botryomonilia scheeleae* (HSAUP H7857). A. Conidiophores, conidiogenous branches, and conidia; B. Conidiophore and conidiogenous branches; C. Conidiogenous cells and conidia; D. Conidia.

branched, producing a dendroid, penicillate head of irregular, finger-like projections. Conidia unicellular, hyaline (pale straw-colored when old), held together in branched chains only by a thin strand of protoplasm connecting the septal pores; the terminal conidia small (2.5–3 µm diam) and more or less hemispherical, but the lower conidia progressively enlarging (mostly to 6.5 × 6 µm, but up to 8 × 4 µm) towards the stalk and doliiform.

Specimen examined: **CHINA, Guangxi Province, Longhu Mountain**, on decaying twigs of an unidentified broadleaf tree, 7 Dec. 2015, C.L. Yang (HSAUP H7857).

Comments—*Botryomonilia scheeleae* is reported for the first time from China. *Botryomonilia* is characterized by single differentiated colonies effused on black stromatic or sclerotial tissue composed of plectenchyma of dark brown hyphae. Conidiophores erect, simple or branched, resembling conidiophores of *Botrytis*, bearing a head of powdery conidia. Heads at first composed of branched, penicillate conidiogenous cells; later, these branches producing solitary or catenate conidia by thallic-arthric disarticulation, resembling *Monilia*. Conidia unicellular, doliiform, connected by protoplasmic filaments. The Chinese specimen closely matches the original description of *B. scheeleae*, except that the type material had wider conidiophores (15–20 µm; Goos & Piroz. 1975).

Camposporium ramosum Whitton, McKenzie & K.D. Hyde, Fungal Diversity 11: 183, 2002. Fig. 3

Colonies on natural substrate effuse, consisting of individual conidiophores scattered over the substrate surface, brown. Mycelium immersed and superficial. Conidiophores 39–87 µm long, 3.5–6 µm diam. towards the base, macronematous, mononematous, solitary, unbranched, erect, irregularly cylindrical, flexuous, dark brown towards the base, fading to pale brown towards the apex, smooth, 4–10-septate, thickened walls and septa. Conidiogenous cells holoblastic, polyblastic, integrated into the apical region of the conidiophores, pale brown, smooth, denticulate; cylindrical denticles acting as separating cells, 1–3 denticles per conidiophore. Conidia 50–55.5 µm long, 5–6.5 µm diam. at the widest point, solitary, dry, cylindrical, brown or pale brown, slightly thickened walls and septa, 7–9-septate, apex rounded; basal cell truncate, often with a persistent portion of the denticle attached; the apical cell giving rise to a single simple or branched appendage; appendage hyaline, 1–2-septate, smooth, tapering from the base to the apex, close to the base typically dividing into 3 (rarely 2) terminal branches, individual branches 11–27 µm long.

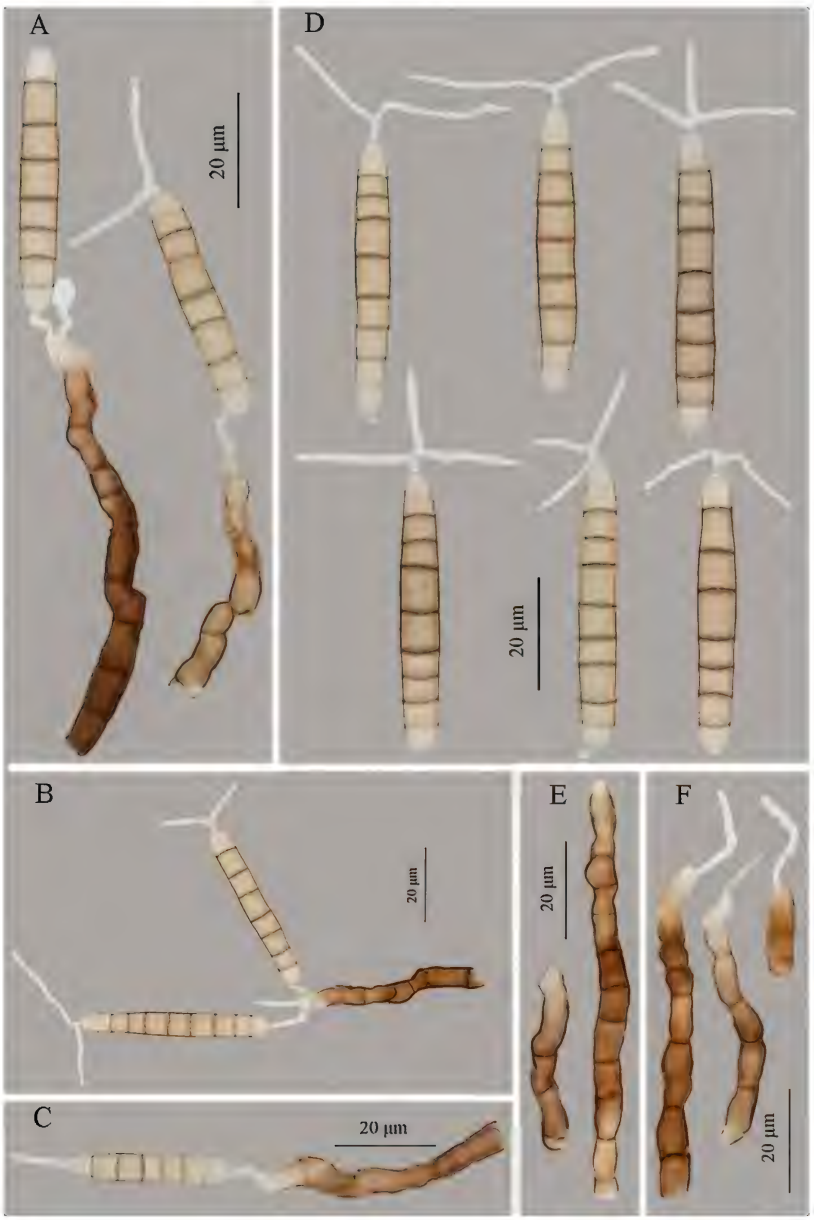

Fig. 3. *Camposporium ramosum* (HSAUP H7919). A–C. Conidiophores, conidiogenous cells, and conidia; D. Conidia; E. Conidiophore; F. Conidiophores and conidiogenous cells.

Specimen examined: **CHINA, Jiangxi Province, Jiuling Mountain**, on decaying twigs of an unidentified broadleaf tree, 2 Nov. 2016, C.L. Yang (HSAUP H7919).

Comments—*Camposporium ramosum* has been reported from Australia and USA but has not previously been recorded in China. The genus is characterized by dematiaceous, simple conidiophores that bear terminal, integrated, denticulate conidiogenous cells. The conidia are typically cylindrical and elongate multiseptate, rounded at either or both ends; the apex is either simple or has one or more cylindrical appendages, and the base typically has a persistent portion of the denticle attached. The Chinese specimen closely matched the protologue description of *C. ramosum*, except that the type specimen had bigger conidia with more septa (80–112 × 6.4–9.6 μm, 8–15-septate; Whitton et al. 2002).

Acknowledgments

The authors express gratitude to Dr. Rafael F. Castañeda-Ruiz and Dr. Jian Ma for serving as pre-submission reviewers and for their valuable comments and suggestions. This project was supported by the National Natural Science Foundation of China (Nos. 31093440, 31230001, 31493010, 31493011, 31200013) and the Ministry of Science and Technology of the People's Republic of China (Nos. 2006FY120100).

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MYCOTAXON

ISSN (print) 0093-4666 (online) 2154-8889 Mycotaxon, Ltd. ©2017

October–December 2017—Volume 132, pp. 775–778

https://doi.org/10.5248/132.775

Pseudocercospora lysidices sp. nov. on *Lysidice rhodostegia* from China

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Abstract—*Pseudocercospora lysidices* on *Lysidice rhodostegia* (*Fabaceae* subfam. *Caesalpinioideae*) is introduced as a new species, based on Chinese specimens previously misidentified as "*Pseudocercospora lathyri*." The new species is described, illustrated, and compared with other *Pseudocercospora* species on caesalpiniaceous hosts. The specimens examined are deposited in the Herbarium of the Institute of Microbiology, Chinese Academy of Sciences, Beijing (HMAS).

Key words—anamorphic ascomycete, *Cercospora*, taxonomy, cercosporoid fungi

Introduction

Cercospora lathyri Dearn. & House was described on *Lathyrus japonicus* [= *L. martimus*] (*Fabaceae* subfam. *Faboideae*), forming angular leaf spots, relatively large stromata (30–60 µm diam.), short and narrow conidiophores (5–20 × 3–4 µm), and conidia (40–75 × 2–3.5 µm), but without any details on the conspicuousness of the conidiogenous loci (House 1916). Guo & Liu (1992), who examined a Chinese collection of a cercosporoid hyphomycete on *Lysidice rhodostegia*, considered the morphological characteristics of this fungus to be rather similar to those of *Cercospora lathyri*, an assumption that was based only on descriptions of the latter species and without examining the type material. They assigned the Chinese material to *C. lathyri*, and introduced the new combination *Pseudocercospora lathyri* (Dearn. & House) Y.L. Guo &

X.J. Liu due to unthickened and undarkened conidiogenous loci and hila of the conidia. Braun & Mel'nik (1997) re-examined the type specimen of *C. lathyri* and found small but conspicuously thickened and darkened conidiogenous loci and hila and subcylindrical-filiform acicular to narrowly obclavate hyaline conidia, suggesting that *C. lathyri* must be maintained in *Cercospora* s. str. and that the *Pseudocercospora* found on *Lysidice rhodostegia* in China represents a different species, which we describe here as a new species, *Pseudocercospora lysidices*.

Materials & methods

The original collection of the specimen in 1961 is described in the Type designation section. Small pieces of leaf lesions were cut off and heated in Lactic acid-phenol-glycerol-distilled water (1:1:2:1) between slides and coverslips over flame to become transparent. The tissues were examined microscopically without any staining using oil immersion (bright field and phase contrast) lenses on a standard light Olympus CX 21 microscope. Thirty conidia and other structures were measured using 400 magnification; the measurement ranges include the extremes given in parentheses. The type specimen is deposited at the Mycological Herbarium of Academia Sinica, Beijing, China (HMAS)

Taxonomy

Pseudocercospora lysidices Y.L. Guo & F.Y. Zhai, **sp. nov.** FIG. 1

MycoBank MB 819544

Misapplied name: "*Pseudocercospora lathyri*" sensu Y.L. Guo & X.J. Liu (1992).

Differs from *Pseudocercospora guanicensis* in its distinct amphigenous leaf spots, its larger stromata, its shorter and narrower pale olivaceous conidiophores, and its cylindrical-obclavate, paler, shorter, and much narrower conidia.

Type: China, Guangdong Province, Guangzhou, on living leaves of *Lysidice rhodostegia* Hance (*Fabaceae* subfam. *Caesalpinioideae*), 7 XI 1961, coll. Q.M. Ma & X.J. Liu (**Holotype,** HMAS 59072).

Etymology: referring to the host genus *Lysidice*.

Leaf spots amphigenous, subcircular, angular to irregular, 2–8 mm diam., grayish white in the center, margin dark brown or totally dark brown on the upper surface, brown to dark brown on the lower surface. Caespituli amphigenous. Mycelium internal. Stromata globose, dark brown, 25–65 µm diam. Conidiophores densely fasciculate, pale olivaceous, uniform in color, irregular in width, not branched, geniculate in the upper part, straight to curved, obtusely rounded to conical at the apex, 0–1-septate, thin-walled, smooth, 6.5–22(–30) × 2.5–4.3 µm. Conidiogenous cells integrated, terminal or conidiophores reduced to conidiogenous cells, conidiogenous loci inconspicuous, unthickened, undarkened. Conidia solitary, cylindrical-

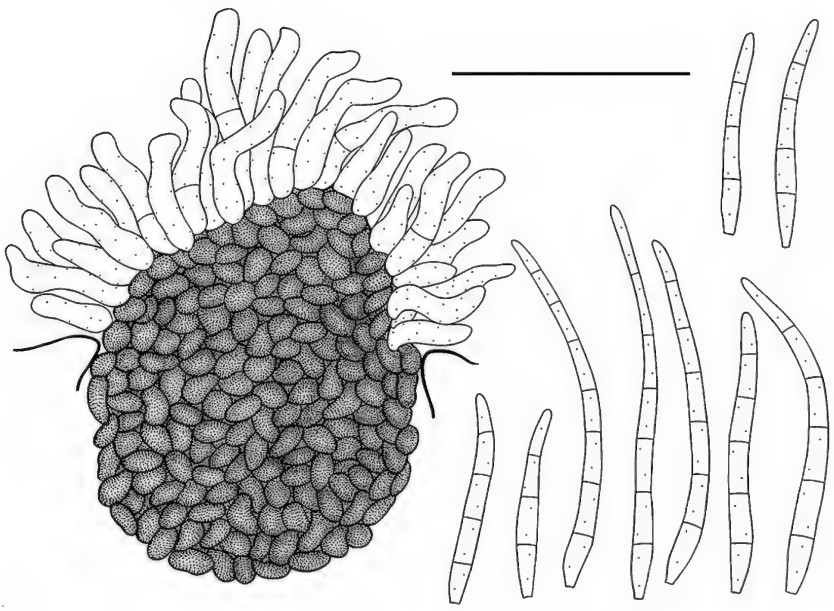

FIG. 1. *Pseudocercospora lysidices* (holotype, HMAS 59072). Conidiophores and conidia. Scale bar = 40 μm.

obclavate, subhyaline to very pale olivaceous, straight to curved, obtuse at the apex, obconically truncate to almost truncate at the base, inconspicuously 3–7-septate, thin-walled, smooth, 24–86.5 × 2.2–3.5 μm.

NOTES: There are four other *Pseudocercospora* spp. described on hosts belonging to the *Fabaceae* subfam. *Caesalpinioideae: Pseudocercospora caesalpiniae* T.K. Goh & W.H. Hsieh, *P. caesalpiniigena* U. Braun, *P. caesalpiniicola* U. Braun et al., and *P. guanicensis* (E. Young) U. Braun & Crous, but they differ in some respects from the new species.

Pseudocercospora caesalpiniae, although also forming angular to irregular leaf spots, amphigenous caespituli, and short and narrow conidiophores (5–15 × 1.5–3 μm), differs from *P. lysidices* in its external mycelium with solitary conidiophores, the lack or production of smaller stromata (≤40 μm diam.), and its acicular to narrowly obclavate conidia (Goh & Hsieh 1989).

Pseudocercospora caesalpiniigena [≡ *Cercoseptoria caesalpiniae* J.M. Yen et al.] differs from *P. lysidices* in lacking stromata and in forming indistinct leaf spots, longer and broader conidiophores (30–60 × 4–5 μm), and cylindrical conidia (Yen et al. 1982, Braun & Freire 2004).

Pseudocercospora caesalpiniicola [≡ *Phaeoisariopsis caesalpiniae* J.M. Yen et al.] also forms large stromata (40–75 µm diam.) but is distinguished from *P. lysidices* by indistinct leaf spots, synnematous and hypogenous conidiomata, and longer and broader conidiophores (20–150 × 3–5 µm) and conidia (20–110 × 2.5–4.5 µm) (Yen et al. 1982, Hernández-Gutiérrez & Dianese 2009).

In comparison to *P. lysidices, P. guanicensis* [≡ *Cercospora guanicensis* E. Young] also forms circular to subcircular leaf spots and small stromata (30–45 µm diam.), but its conidiophores are arranged in dense fascicles, darker in color (olivaceous brown), and much longer and broader (20–215 × 4–8 µm) and its conidia are obclavate to obclavate-cylindrical and longer and broader (40–105 × 5–7 µm; U. Braun, pers. comm.; Chupp 1954; Crous & Braun 2003).

Acknowledgments

This study was supported by the Project for Fundamental Research on Science and Technology, Ministry of Science and Technology of China (No. 2013FY110400), the National Natural Science Foundation of China (No. 31100013) and The Cultivation Program of Youth Backbone Teachers in Colleges and Universities of Henan Province (2016GGJS-109). We express our deep appreciation to Prof. Uwe Braun and Mark L. Gleason for their valuable suggestions, kind help, and their assistance during the course of submission of this manuscript.

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MYCOTAXON

ISSN (print) 0093-4666 (online) 2154-8889 Mycotaxon, Ltd. ©2017

October–December 2017—Volume 132, pp. 779–787

https://doi.org/10.5248/132.779

Bactrodesmiastrum domesticum sp. nov. and *Conioscypha varia* from indoor environments

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Abstract—Two hyphomycetes were collected from residences: a new species, *Bactrodesmiastrum domesticum*, with turbinate or obtriangular conidia and *Conioscypha varia*, reported for the first time from an indoor environment.

Key words—building, dry wall, asexual fungi, water damage, wood

Introduction

Indoor environments provide man-made and unique habitats for fungi. Building materials, such as drywall and wood, and household materials such as clothing, fabric, books, paper products, foodstuffs, etc. are good substrates for fungi whenever water or moisture is available. There have been historical studies on indoor fungi (e.g., the notorious *Stachybotrys chartarum* (Ehrenb.) S. Hughes [= *Stachybotrys atrus* Corda] collected from an indoor wall in Prague during the early 19th century; Corda 1837), but fungal diversity in indoor environments has not been well studied, perhaps due to the misconception that fungal diversity in indoor environments is simple and straightforward. However, an increasing number of fungi have been added to the list of indoor fungi in the last two decades, some new to science and others as first records

for the countries where they were collected. We report here on two unique hyphomycetes were collected from indoor environments in the USA, one a new species and the other representing a first occurrence for an indoor environment.

Materials & methods

Two fungi were collected during indoor mold inspections in Florida and Massachusetts. These fungi were grown on malt extract agar (MEA), corn meal agar (CMA) and dichloran glycerol agar (DG18) at 25°C. A small scalpel was used to remove fungal structures directly from the samples or from culture for morphological observation under a compound microscope. Conidiophores, conidiogenous cells, and conidia were mounted in 85% lactic acid or lacto-fuchsin (0.1 g acid fuchsin, 100 ml 85% lactic acid; Carmichael 1955) and microscopically observed and measured using an Olympus BX40 compound microscope equipped with Nomarski differential interference contrast optics and photographed using an Olympus Microfire digital camera (Goleta, CA). The fungal structure measurements were statistically analyzed using Microsoft Office Excel 2013 with 95% confidence interval of means. The results are presented as ranges of the measurement. Specimens were conserved in the Herbarium, Connecticut Agricultural Experiment Station, New Haven, CT, USA (NHES).

Taxonomy

Bactrodesmiastrum domesticum D.W. Li & Chin S. Yang, **sp. nov.** PLATE 1

MYCOBANK MB 820855

Differs from *Bactrodesmiastrum monilioides*, *B. obovatum*, and *B. obscurum* by its much larger turbinate conidia and from *B. pyriforme* by its much wider turbinate conidia.

TYPE: USA, Florida, Miami Shores, unidentified decayed wood (floor plank) in a residence, 18 March 2013, Albert Baerren, Prestige 130320-01-001 (**Holotype**, NHES L1701).

ETYMOLOGY: epithet is named after the indoor habitat where this fungus was collected.

COLONIES on the natural substrate effuse, sparse, light brown. Mycelia partly superficial and partly immersed in the decayed wood. Hyphae branched, septate, pale brown to brown, smooth, thick-walled, 2.5–3 µm diam. CONIDIOPHORES poorly differentiated or undifferentiated, often reduced to conidiogenous cells, very rarely developing a septum and separated into two cells, straight, rarely flexuous, unbranched, solitary. CONIDIOGENOUS CELLS monoblastic, smooth, thick-walled, pale brown to brown, much darker than the adjacent hyphal cells to both sides, (4.5–)3.7–7(–8) µm (n = 6) long, (2.5–)3.5–5.5 µm (n = 6) diam at the base, determinate, attenuated towards the apex, conical, tubular, barrel-shaped or (rarely) ovoid, truncate at the apex, occasionally L shaped or short inverse T shaped, 2–4.5(–5) µm (n = 11) diam. CONIDIAL SECESSION schizolytic CONIDIA (2–)3(–4) septate, acrogenous, turbinate or obtriangular

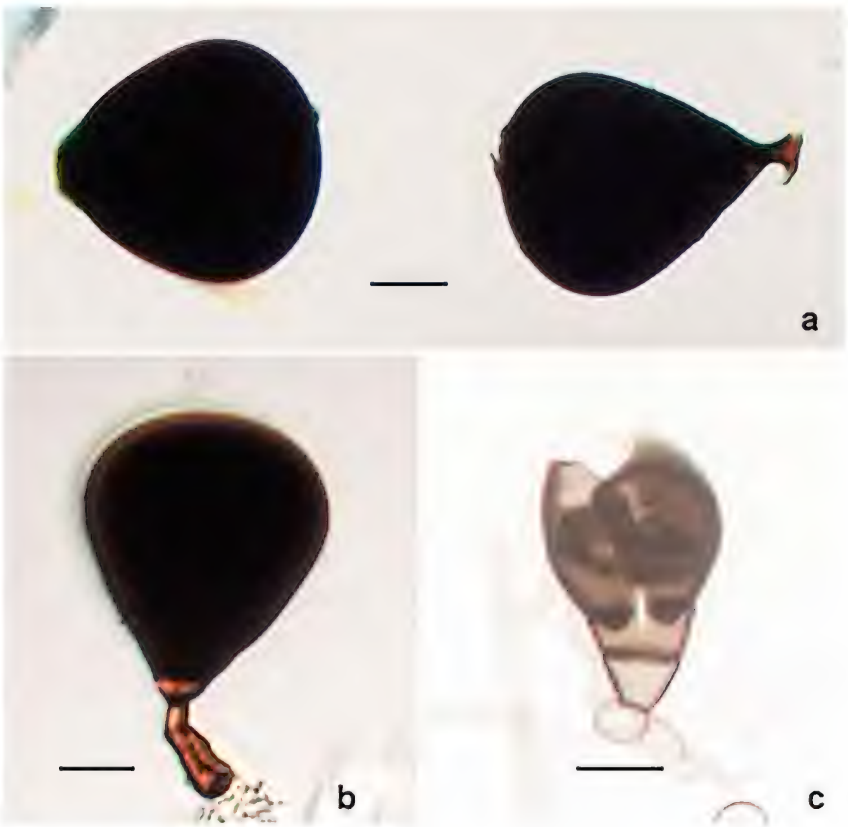

Plate 1. *Bactrodesmiastrum domesticum* (holotype, NHES L1701). a. Conidia and conidiogenous cell; b, c. Conidia and conidiogenous cells. Scale bars = 10 μm.

with a rounded distal side, black, smooth, glistening, solitary, dry, (36.5–) 39.5–43.5(–47) × (30–)33–37(–37.5) μm (n = 30), with distal cells darker than the proximal cell, conico-truncate at the base. Sexual state unknown.

Notes: *Bactrodesmiastrum* Hol.-Jech. is characterized by solitary or poorly aggregated differentiated or undifferentiated conidiophores reduced to a conidiogenous cell that is monoblastic, brown, single (Holubová-Jechová 1984) and contrasts with *Bactrodesmium*, which develops sporodochia and differentiated, colorless to brown, simple or branched conidiophores that develop mono- or polyblastic conidiogenous cells (Ellis 1971, Holubová-Jechová

1972). *Bactrodesmiastrum* was typified by *B. obscurum* Hol.-Jech. (Holubová-Jechová 1984), which has flask-shaped conidiogenous cells with a truncate apex and obovoid versicolored conidia with a conico-truncate basal cell. Hernández-Restrepo et al. (2013) added two new species, *Bactrodesmiastrum pyriforme* M. Hern.-Rest. et al. and *B. obovatum* (M. Calduch et al.) J. Mena et al. [≡ *Janetia obovata* M. Calduch et al.].

When describing another new species, *B. monilioides* Hern.-Rest. et al., Hernández-Restrepo et al. (2015) emended the genus by expanding the conidiophore description from "reduced to a conidiogenous cell which is monoblastic, brown, single" to "semi-macronematous or macronematous, mononematous, simple, usually reduced to conidiogenous cells arranged singly or aggregated in small groups, or conidiophores arising from pulvinate to subpustulate, scattered and black sporodochial conidiomata". All four previously published species were collected or isolated from decaying or submerged wood or twigs and exclusively in Europe; *B. domesticum* represents the first *Bactrodesmiastrum* species reported from a different habitat as well as from another part of the world.

Bactrodesmiastrum domesticum can easily be distinguished from *B. monilioides*, *B. obovatum*, and *B. obscurum*, which have much smaller non-turbinate conidia: *B. monilioides* 24–35 × 15–18 µm, *B. obovatum* 22.5–33.5 × 12–15 µm, and *B. obscurum* 24–35 × 11–15 µm. (Hernández-Restrepo et al. 2013, 2015; Holubová-Jechová 1984). *Bactrodesmiastrum domesticum* and *B. pyriforme* develop conidia of similar lengths, but those of *B. pyriforme* are pyriform and narrower (14–28 µm; Hernández-Restrepo et al. 2013).

Bactrodesmiastrum domesticum also resembles *Trichocladium achrasporum* (Meyers & R.T. Moore) Shearer & J.L. Crane, *T. nypae* K.D. Hyde & Goh, and *T. palmae* Manohar. et al. in morphology of conidia and conidiogenous cells. However, *T. achrasporum* develops sporodochia and produces much smaller (17–24 µm × 10–16) conidia (some with dark bands at the septa) that are pyriform, not turbinate (Shearer & Crane 1971); *T. nypae* develops much smaller (15–20 × 10–13 µm) and pyriform to ellipsoidal conidia (Hyde et al. 1999); and *T. palmae* has finely verrucose conidia (28–36.5 × 18.5–24 µm; Manoharachary et al. 2006).

Both *Bactrodesmium linderi* (J.L. Crane & Shearer) M.E. Palm & E.L. Stewart and *Ba. moenitum* (J.L. Crane & Shearer) M.E. Palm & E.L. Stewart resemble *B. domesticum* somewhat in conidial morphology. However, these species clearly differ from *B. domesticum: Ba. linderi* by its production of sporodochia and its much smaller pyriform conidia (15–28 × 11–18 µm) and *Ba. moenitum*

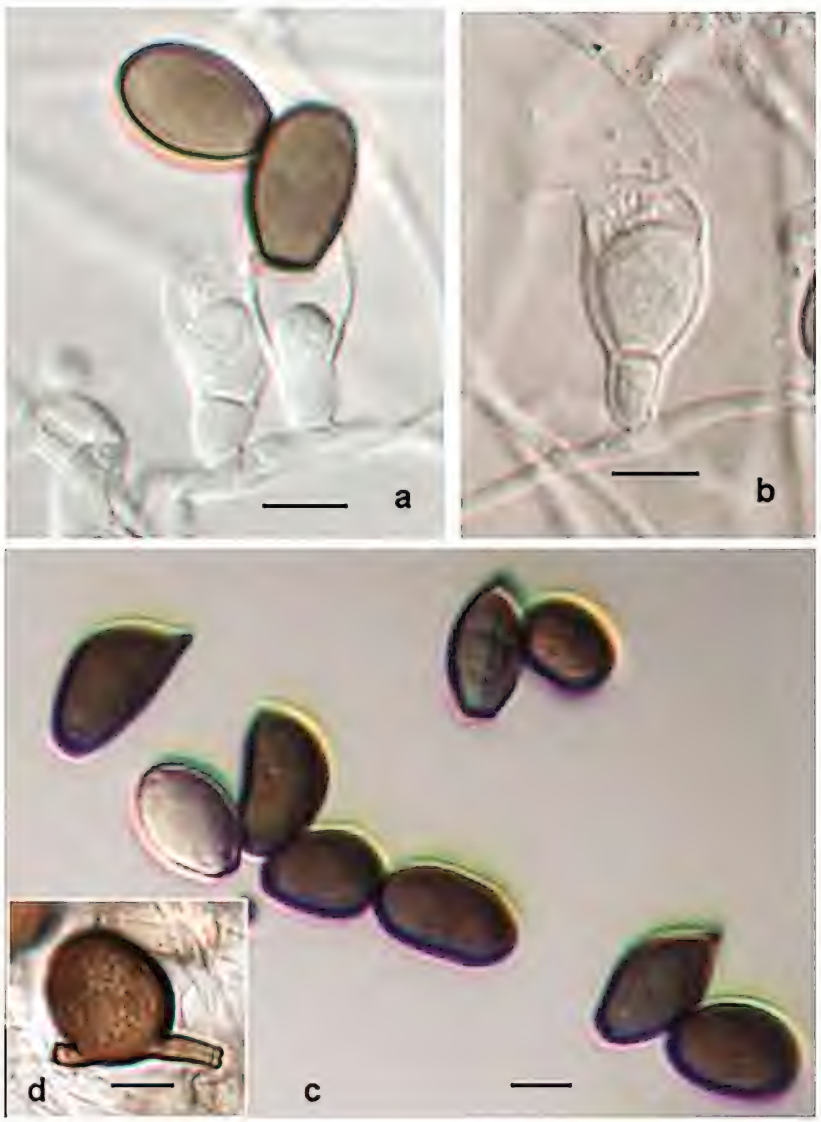

Plate 2. *Conioscypha varia* (NHES L1702). a. Conidia and conidiogenous cells; b. Conidiogenous cell; c. Conidia; d. Conidium developed on hypha. Scale bars = 5 µm.

by its production of sporodochia and its much narrower pyriform conidia (31–48 × 11–27 µm; Palm & Stewart 1982).

Hernández-Restrepo et al. (2013) found that *Ascotaiwania persoonii* Fallah et al., *B. obovatum*, and *B. pyriforme* formed a monophyletic clade with 99% support. (The anamorph of *A. persoonii* is unknown; Fallah et al. 1999). This clade was sister (with 99% support) to a /Savoryellales clade that included three different *Ascotaiwania* species. Similarly, Hernández-Restrepo et al. (2015, in an analysis that did not include *A. persoonii*) found that *B. monilioides*, *B. obovatum*, and *B. pyriforme* formed a monophyletic clade with 99% support that was sister (with 95% support) to a /Savoryellales clade that included four different *Ascotaiwania* species (including the type species, *A. lignicola*). The extensive phylogenetic analysis by Yang et al. (2016) defined a major lineage (with 100% support), which they proposed as a new family and order (*Fuscosporellaceae*, *Fuscosporellales*); this included *B. monilioides*, *B. obovatum*, and *B. pyriforme*, as well as *A. persoonii*, which they recombined as the type of a new genus *Pseudoascotaiwania* Jing Yang et al., remote from *Ascotaiwania* sensu stricto (*Savoryellales*).

Our attempts to culture *B. domesticum* have been unsuccessful. *Trichoderma koningii* Oudem., *Scopulariopsis brevicaulis* (Sacc.) Bainier, and *Fusicladium aromaticum* (Ellis & Everh.) K. Schub. & U. Braun [≡ *Cladosporium aromaticum* Ellis & Everh.] co-existed on the same wood sample.

Conioscypha varia Shearer, Mycologia 65: 133 (1973) PLATE 2
≡ *Conioscyphascus varius* Réblová & Seifert, Stud. Mycol. 50(1): 101 (2004)

COLONIES growing slowly on MEA and CMA, no growth on DG18; reaching 21–24 mm diam on MEA and 22–24 mm diam on CMA after four weeks at 25°C; on MEA black, velvety, partly immerse, raised at center with a serrate 2.5 mm wide white edge band, radially sulcate, reverse dark gray; on CMA mycelium white, inconspicuous, colonies low, plane, buff, pale gray at center on both sides. Hyphae colorless, thin-walled, septate, smooth, some cells moniliform. CONIDIOPHORES undifferentiated, single, short, colorless, smooth, unicellular, reduced to conidiogenous cells. CONIDIOGENOUS CELLS intercalary or terminal, colorless, cyathiform, (2.7–)3.8–5.4(–5.6) × (2.4–)2.8–3.6(–4.1) µm (n = 20), with a colorless multilayered cup-shaped collarette formed by previously ruptured outer conidiogenous cell walls. CONIDIA 1-celled, solitary, smooth, thick-walled, translucent when immature, becoming dark brown when mature, variably shaped, most ellipsoidal, ovoid, or pyriform with a germ pore at the apical and basal ends, a few subspherical or even irregular, (9.5–)10.5–13.5(–14.7) × (6–)6.3–7.3(–7.5) µm (n = 30), some with truncate basal end (2.2–)2.7–3.3(–4) µm (n = 30) or apiculate, developing singly and successively

by percurrent extensions of the conidiogenous cell apices, secession schizolytic, occasionally conidia developing directly on hyphae; mature conidia seceding and released by rupture at the apex of the conidiogenous cell outer wall. Each conidium leaves a layer of cup-like collarette in which a new conidium will develop.

Specimen examined: **USA, Massachusetts**, Hingham, wall of a residence, 4 February 2013 (NHES L1702).

Distribution: Czech Republic, Panama, USA.

Substrates/hosts: Dry wall, *Scheelea zonensis* (Corozo palm), decayed wood of *Ulmus glabra* and an unidentified deciduous tree, and submerged *Ochroma pyramidale* (balsa) wood (Piepenbring 2006; Shearer 1973).

Notes: Höhnel (1904) erected *Conioscypha*, typified by *C. lignicola* Höhn. Shearer (1973), who described *Conioscypha varia* based on a specimen collected from submerged balsa wood in the Patuxent River, MD, USA, emended the generic concept of *Conioscypha* with detailed information from her study on the conidiogenesis of *C. lignicola*. Réblová & Seifert (2004) established *Conioscyphascus*, a new ascomycete genus in which both species, *Conioscyphascus varius* (type species) and *Conioscyphascus gracilis* (Munk) Réblová & Seifert, develop *Conioscypha* anamorphs. Their phylogenetic LSU sequence analyses place *C. japonica* Udagawa & Toyaz., *C. lignicola*, and *Conioscyphascus varius* in a monophyletic clade. *Conioscypha* (proposed in 1904 and with 17 species) has priority over *Conioscyphascus* (proposed in 2004 and with only two species) and is the generic name of choice for both the asexual and sexual morphs under the "1Fungus :1Name" principle. The *C. varia* isolate collected indoors in Massachusetts did not develop the teleomorph.

Conioscypha varia is reported here as an indoor fungus for the first time. The isolate collected indoors from drywall grew at a similar rate on CMA and MEA, but produced no growth on DG18, indicating that *C. varia* is a hydrophilic, not xerophilic, fungus. The holotype and four specimens of *C. varia* were all collected during 1967–1969 from submerged balsa wood in Patuxent (Shearer 1973), a habitat indicating that it is an aquatic fungus. Its ecological characters would make *C. varia* useful as an indicator fungus for long-term water damage in indoor environments. After 40 years since this species was collected and proposed as a new species, *C. varia* was once more collected in the USA, but this time from an indoor environment and not from wood submerged in the water.

It is possible that *C. bambusicola* Matsush. is conspecific with *C. varia*. Conidia of these two species are similar in size. Conidia of *C. bambusicola* are

ovate and apiculate, while those of the *C. varia* holotype are variably shaped—ovoid flammiform, naviculiform, subellipsoidal—with apiculate or rounded apices and some conidia are ovoid, naviculiform, apiculate (Shearer 1973). The shapes of the mature conidia from the isolate collected from the Massachusetts indoor environment appeared similarly variable as those described by Shearer (1973), while the immature conidia were mostly ovoid and apiculate, resembling those described for *C. bambusicola*. Conidia from the isolate of *C. varia* studied by Réblová & Seifert (2004) were ellipsoidal with a rounded apex. The status, delineation, and relationship of these two species should be further studied.

Acknowledgments

The authors are very grateful to Dr. Rafael F. Castañeda Ruiz and Dr. Jian Ma and for their critical review of the manuscript and to Drs. Theodore G. Andreadis and James A. LaMondia for their pre-submission review. The authors are very appreciative to Dr. Lorelei L. Norvell for her editorial review and Dr. Shaun Pennycook for his nomenclature review. The authors are appreciative to Albert Baerren of Conestoga-Rovers & Associates for providing the sample of *Bactrodesmiastrum domesticum* and to Z-H Li for his assistance in obtaining literature otherwise unavailable to the authors.

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MYCOTAXON

ISSN (print) 0093-4666 (online) 2154-8889 Mycotaxon, Ltd. ©2017

October–December 2017—Volume 132, pp. 789–797

https://doi.org/10.5248/132.789

Russula brunneovinacea sp. nov., from northeastern China

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Abstract—*Russula brunneovinacea* is described as a new species from northeastern China. It is characterized by its deep brownish vinaceous to Etruscan red or Kaiser brown pileus with a slightly depressed center, incurved margin with striate, Naples Yellow context that dries with a greyish tinge, subglobose to broadly ellipsoid basidiospores with an amyloid plage and isolated warts that are connected at base or in ridges warts but do not form a reticulum. The new species is supported by ITS phylogenetic analyses and tentatively placed in *Russula* subsect. *Integroidinae* based on morphological analyses.

Key words—macrofungi, *Russulaceae,* taxonomy

Introduction

Russula Pers. (*Russulaceae*, *Russulales*, *Basidiomycota*) was erected by Persoon (1796) and with a worldwide distribution (Kirk et al. 2008). The genus, which is ectomycorrhizal, includes many important edibles such as *R. griseocarnosa,* popular in China and Southeast Asia (Wang et al. 2009, Li et al. 2010, Zhao et al. 2015) as well as poisonous species such as *R. emetica* (Schaeff.) Pers. and *R. subnigricans* Hongo (Miller & Buyck 2002, Yang & Piepenbring 2004, Li et al. 2015).

Russula subsect. *Integroidinae* (Romagn.) Bon was validated by Bon (1986), based on *R.* sect. *Integroidinae* Romagn. (Romagnesi 1958). Subsequently Bon placed the subsection within *R.* sect. *Lilaceae* (Bon 1988). In this paper, we follow the taxonomy of Bon (1986), who characterized species within this subsection by a pileus with red, yellow, purple and complex color, a grayish

context with a rarely blackening tinge, pileocystidia that are absent or rarely septate when present, and sometimes with primordial hyphae.

During our research on species diversity of *Russula* in the Changbai Mountains of northeastern China, we identified two interesting *Russula* collections as a novel taxon, which we tentatively place in *R.* subsect. *Integroidinae* based on detailed morphological examination.

Materials & methods

Specimens, collected from Changbai Mountains, Jilin Province, during 2012, were photographed in the field, with macroscopic descriptions of the fresh fruiting bodies based on the photos and notes made in the field. After being dried at 50–55°C with an electric drier, the collections were deposited at the Research Institute of Tropical Forestry, Chinese Academy of Forestry Sciences, Guangzhou, China (RITF). Terminology for descriptive terms follows Vellinga (1988). Color names and codes refer to Ridgway (1912).

For microscopic observations, sections of specimens were cut by hand, mounted in 5% KOH, and then stained with Congo red. We used Melzer's reagent to determine spore amyloidy and Cresyl Blue to test spores for a metachromatic reaction (Singer 1986). Sulfovanillin (SV) was used to test for reactions of cystidia. Sizes of basidia, basidiospores, cheilocystidia, pleurocystidia and elements of the pileus covering were measured using the MShot Digital Imaging System. The abbreviation [n/m/p] denotes measurements made on 'n' basidiospores in 'm' basidiomata from 'p' collections. Basidiospore dimensions follow the notation (a–)b–c(–d); the range 'b–c' includes 90% of the measured values with the extreme values ('a', 'd') given in parentheses. The spore quotient Q indicates the length/width ratio of spores, and Qav denotes the average Q of all basidiospores ± sample standard deviation.

DNA was extracted from dried materials with an improved CTAB protocol (Zhou & Liang 2011). Sequences of ITS region were amplified with the primers ITS5 and ITS4 (White et al. 1990). PCR products were purified using the Bioteke DNA Purification Kit. Both strands were sequenced with an ABI 3730 DNA analyzer and an ABI BigDye 3.1 terminator cycle sequencing kit (Shanghai Sangon Biological Engineering Technology & Services). These newly generated sequences were submitted to GenBank.

DNA sequences were edited and aligned by SeqMan (DNA STAR Package) and MUSCLE (Edgar 2004) and manually checked and adjusted. Ambiguously aligned positions were excluded from the matrix. Gaps in alignment were treated as missing data. All unambiguous characters and character transformations were equally weighted. A blast search of the query sequence in GenBank was performed to determine the most closely related taxa for molecular identification. A dataset was generated from the highest scored hits most relevant for identification, as well as from samples previously used in the phylogenetic reconstruction of *Russula* (Miller & Buyck 2002). *Russula virescens* (Schaeff.) Fr. and *R. foetens* Pers. were chosen as outgroup taxa.

Maximum likelihood (ML) and Bayesian analyses were used to generate a phylogeny. The ML tree generation and bootstrap analyses were performed with the RAxML BlackBox online server (Stamatakis et al. 2008). All parameters in RAxML analysis were at default, statistical support values were obtained using nonparametric bootstrapping with 1000 replicates, and trees obtained prior to convergence were discarded before the consensus tree. A bootstrap proportion greater than 75% is considered significant. The results were subsequently exported to Dendroscope for tree viewing and editing (Huson et al. 2007).

The dataset was further analyzed with MrBayes 3.1 (Huelsenbeck & Ronquist 2005) under a general-time reversible (GTR) model (nst = 6) and the parameter model was selected by the Akaike Information Criterion (AIC) as the best-fit likelihood model with Modeltest 3.7 (Posada & Buckley 2004). Bayesian analyses were run 6 chains for 1.0 million generations with sampling every 1000 generations. Trees were pooled together and used to generate a 50% majority-rule consensus tree with branch lengths. Nodes that were recovered more than 95% of the time were considered to have a significant posterior probability.

Taxonomy

Russula brunneovinacea X.M. Jiang, Yang K. Li & J.F. Liang, & **sp. nov.** FIG.1

MycoBank MB 819154

Differs from *Russula griseocarnosa* by its deep brownish vinaceous to etruscan red or kaiser brown pileus, barium yellow spore print, and smaller basidiospores with smaller spines.

Type—China, Jilin Province, Changbai Mountains, Lushuihe hunting ground, alt. 1000 m, 21 August 2012, Zhang Xin 268 (**Holotype**, RITF 2242; GenBank KY114148).

Etymology—The Latin word "*brunneovinacea*" refers to the brownish vinaceous color of the pileus.

Basidiomata medium. Pileus 5–6 cm in diameter, hemispherical when young, expanding to applanate or concave with a slightly depressed center, surface viscid when young and moist, glabrous when mature; Light Coral Red (XIII5′b) to Coral Red (XIII5′) when young, Dark Vinaceous (XXVII1″) to Mineral Red (XXVII1″k) or Burnt Sienna (II9k) at centre after maturity, margin slightly incurved, sometimes undulate and dehiscent, obviously striate, Deep Brownish Vinaceous (XXXIX5‴) to Etruscan Red (XXVII5″) or Kaiser Brown (XIV9′k), often becoming Hay's Russet (XIV7′k) to Russet (XV13′k) or Ocher Red (XXVII5″i) to Prussian Red (XXVII5″k) when dried. Lamellae White (LIII) to Cream Color (XVI19′f), adnate, not forked, lamellulae absent, becoming Chamois (XXX19″b) or Salmon Color (XIV9′d) with greyish tinge when dried. Stipe 4.5–5 × 1–1.5 cm, central, cylindrical to subcylindrical, enlarged towards the base, white, often tinged Hermosa Pink (I1f) tinge when mature, Baryta

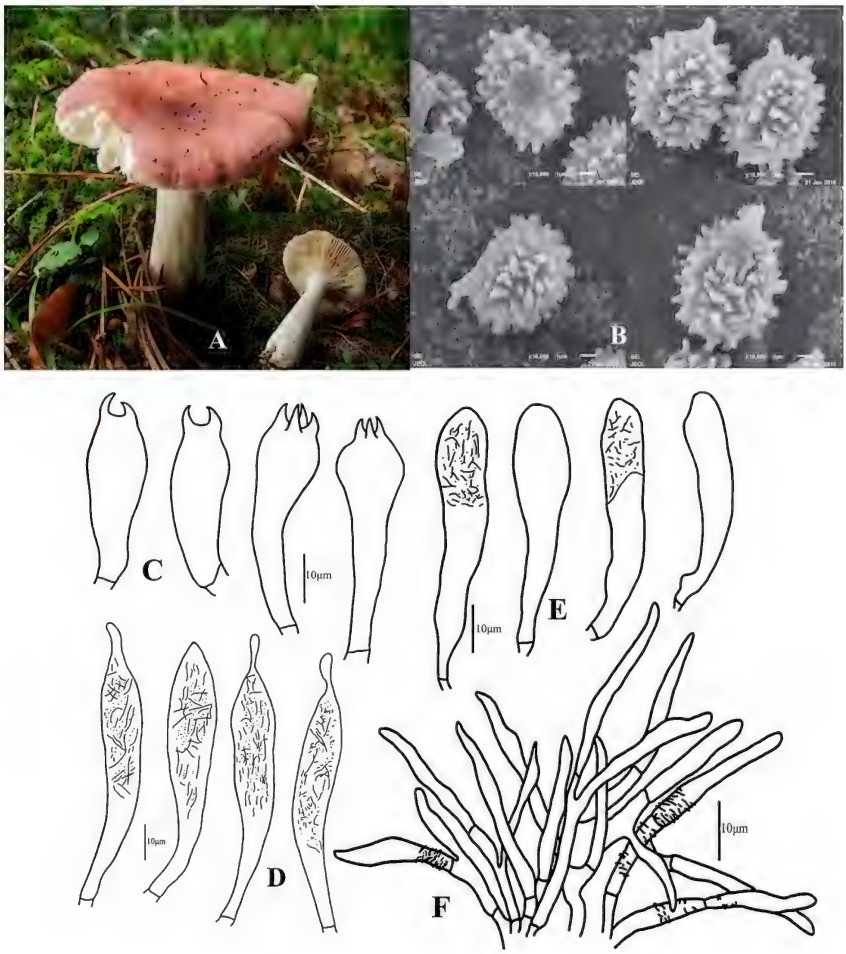

Fig. 1. *Russula brunneovinacea* (holotype, RITF2242). A. Basidiomata; B. Basidiospores; C. Basidia; D. Pleurocystidia; E. Cheilocystidia; F. Pileipellis

Yellow (iv21f) and tinged with Eosine Pink (i1d) when dried, originally solid, then stuffed with a bread-textured trama to irregular cavities, color unchanging when injured. Context white (liii), Naples Yellow (xvi19′d) with greyish tinge when dried. Odor a little sweet. Taste few acrid. Spore Print Barium Yellow (xvi23′d).

Basidiospores [52/2/2] (6.1–)6.2–8.5(–8.8) × (5.1–)5.3–7.1(–7.8) μm, Q = (1.0–)1.03–1.31(–1.43) (Qav = 1.18 ± 0.09), subglobose to broadly ellipsoid,

rarely globose or ellipsoid; ornamentation amyloid; warts bluntly conical to subcylindrical, 0.7–0.9 µm tall, isolated or connected at base or ridges, not forming a reticulum; plage distinctly amyloid; hyaline in 5% KOH. Basidia 32–46(–52) × 10–13.5 µm, narrowly clavate to clavate, inflated towards upper half, 4-spored, rarely 2-spored, hyaline in KOH, sterigmata about 2.5–4.5 µm long. Lamellar trama mainly composed of nested sphaerocytes (28–41 × 26–33 µm) surrounded by connective hyphae. Pleurocystidia 54–89 × 9–13 µm, abundant, narrowly clavate to clavate, apex often with papillate appendage, with abundant granular contents in the upper part, red to slightly purplish red and weakly grey in SV. Cheilocystidia 43–82 × 7–13 µm, clavate with rounded or indistinctly mucronate apex, few with granular contents. Pileipellis composed of hyaline hyphae (2–5 µm diam.), often branched and interwoven, septate; terminal cells 16–37 × 2.2–4.1 µm, cylindrical, with obtuse apex, sometimes attenuate, and some with zebroid encrustations. Clamp connections absent.

Habitat & distribution — Solitary or dispersed in conifer and conifer–broadleaf forests. So far found only from the type locality.

Additional specimen examined — **China: Jilin Province**, Changbai Mountains, alt. 1000 m, 19 August 2012, Zhang Xin 226 (RITF 2206; GenBank KY114147).

Phylogenetic analyses

A dataset of 32 ITS sequences with 666 nucleotide sites (including 30 available sequences of *Russula* from GenBank) was analyzed. Both the RAxML and Bayesian analyses resulted in similar topologies and only the best maximum likelihood tree with bootstrap supports is shown (Fig. 2). Bayesian posterior probability is also displayed with the bootstrap values along the branches.

Bayesian and RAxML phylogenetic analyses clustered two collections together and obviously separate from the related sequences available on GenBank. Phylogenetic analyses also grouped the new species with *R. griseocarnosa* X.H. Wang et al., *R. occidentalis* Singer, *R. vinosa* Lindblad, and other species with weak statistical support.

Discussion

Russula brunneovinacea is well distinguished by its Deep Brownish Vinaceous to Etruscan Red or Kaiser Brown pileus with a slightly depressed center, its incurved striate margin, its white or cream lamellae that become Chamois with a greyish tinge when dried, its Naples Yellow context with greyish tinge when dried, its somewhat acrid taste, and its subglobose to broadly ellipsoid spores with small isolated or connected at base or ridges warts.

Bayesian and RAxML phylogenetic analyses support *R. brunneovinacea* as closely related to the Chinese specimens previously misdetermined as "*R. vinosa*" and subsequently described as a new species, *R. griseocarnosa* (Wang et al. 2009). *Russula griseocarnosa* differs from *R. brunneovinacea* by its dark red sticky pileus, white context turning greyish during maturity, white spore print, stipe tapered at base, larger basidiospores (8–10 × 6.5–8 μm) with longer (≤2.5 μm) spines, and pleurocystidia (100–150 × 13–20 μm). Geographically, *R. griseocarnosa* invariably grows in tropical and subtropical China while *R. brunneovinacea* grows in northeastern China with a temperate monsoon climate.

Russula occidentalis is also close to *R. brunneovinacea.* A BLAST query showed that the two species have a 92% maximum identification with 91% coverage. However, *R. occidentalis* has a variably colored pileus, lamellae with forking edges that bruise grey to black, a white to creamy white stipe that stains dingy pink where handled or damaged and becomes dark grey to brownish-grey or black, and bigger spores (7.9–11.2 × 6.7–8.9 μm), basidia (52–62 × 14–17.7 μm), and pleurocystidia (70–125 × 9–13 μm) (Romagnesi 1985, Roberts 2007). *Russula vinosa* has a 90% maximum identification with *R. brunneovinacea;* it differs in its vinaceous red, dark wine-red or somewhat brownish pileus, lamellae becoming grey to black when cut or bruised, pale ochre spore print, mild taste and distinctive odor (Romagnesi 1967, Bon 1988).

In the field, *R. brunneovinacea* is easily confused with the United States species *R. rubescens* Beardslee (Romagnesi 1985). *Russula rubescens* also has red color on the pileus, but differs by its paler margin fading with age, mild taste, forked lamellae, white stipe becoming cinereous, and often blackening with age or upon drying, and quickly becoming red and then black when wounded, and basidiospores with an indistinctly amyloid plage. *Russula xerampelina* (Schaeff.) Fr. and *R. olivacea* (Schaeff.) Pers. (Romagnesi 1985, Roberts 2007) also resemble *R. brunneovinacea* in appearance. *Russula xerampelina* is distinguished by its ochraceous-olive young pileus, non-striate margin, warm yellow to light orange-yellow lamellae often staining brown where damaged, cream to light yellow stipe, crab or shrimp odor, light orange yellow spore print, and basidiospores with longer (≤1.2 μm long) warts, while *R. olivacea* differs in its bigger (10–20 cm) basidiomata, drab pileus with olive green and purple hues, non-striate margin, egg-yolk yellow lamellae unchanging when damaged, deep ochre-yellow spore print, and basidiospores with incompletely amyloid plage (Romagnesi 1985, Roberts 2007).

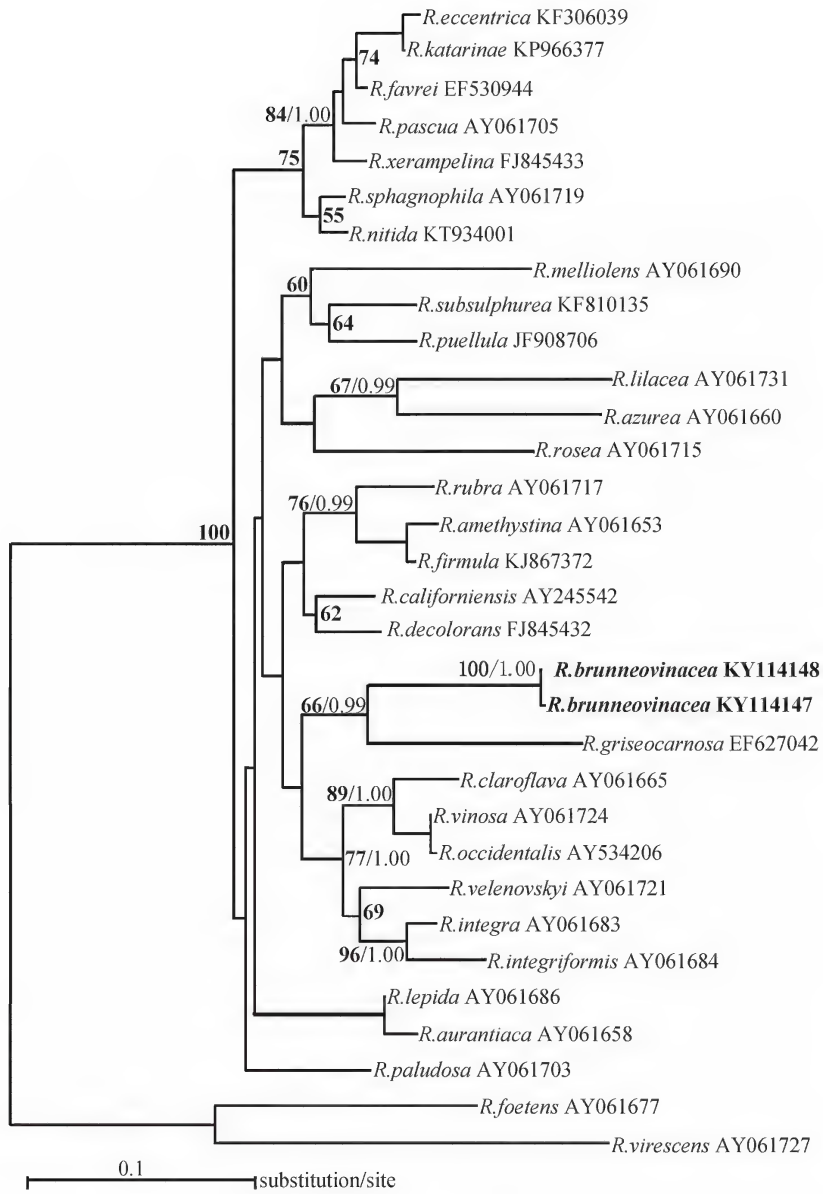

FIG. 2. The best RAxML likelihood tree (–ln L 3803.544073) based on the *Russula* ITS dataset. Support values in bold type are RAxML likelihood bootstrap (≥50%). Values in normal type are Bayesian posterior probabilities (≥0.95).

Acknowledgments

We are grateful to Dr. Yanchun Li and Dr. Baokai Cui for their critical reviews of the manuscript. This work was supported by the National Natural Science Foundation of China (No.31570544), Natural Science Foundation of Guangdong Province (2014A030313727), Forestry Science and technology innovation Fund of Guangdong (2014KJCX019-01) and the National Nonprofit Institute Research Fund of CAF (CAFYBB2014MA003).

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MYCOTAXON

ISSN (print) 0093-4666 (online) 2154-8889 Mycotaxon, Ltd. ©2017

October–December 2017—Volume 132, pp. 799–811

https://doi.org/10.5248/132.799

Amanita pallidorosea in Pakistan and its ectomycorrhizal association with *Quercus oblongata*

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Abstract—The occurrence of *Amanita pallidorosea* in Pakistan and its ectomycorrhizal association are reported for the first time based on morphological characters and nucleotide sequences of the internal transcribed spacer region generated from basidiomata and from ectomycorrhizal roots of *Quercus oblongata* [= *Q. incana* Roxb., nom. illeg.].

Key words—*Amanitaceae*, ITS, lethal, phylogeny, Swat

Introduction

Amanita Pers. (*Agaricales, Basidiomycota*) is a large genus comprising about 500 described species (Bas 2000, Tulloss 2005, Yang 2005, Kirk et al. 2008). Many *Amanita* species have been shown to be ectomycorrhizal, thus playing vital roles in forest ecology (Yang 1997). New *Amanita* species have been regularly reported from all over the world, including East Asia, Central and South America, South Africa, and Australia (Zhang et al. 2015). However, knowledge about the genus is rather limited for Pakistan, where only eighteen species have been reported (Ahmad et al. 1997, Tulloss et al. 2001). The goal of this study was to collect *Amanita* basidiomata and ectomycorrhizae from the *Quercus*-dominated forests of Swat district, Khyber Pakhtunkhwa province, Pakistan. Mycological expeditions took place during the monsoon season (July to September) of 2015. Nuclear ribosomal DNA sequence analyses of

the ITS region from basidiomata and ectomycorrhizal roots were combined with detailed morphological examinations to confirm Pakistani collections as *A. pallidorosea,* a new record for Pakistan. We describe the ectomycorrhiza of this species here for the first time.

Materials & methods

Sampling site

Different sites dominated by oak forests were selected for sampling within district Swat (34°34′–35°55′N 72°08′–72°50′E). The Swat valley, well known for its biodiversity, is in Pakistan's Khyber Pakhtunkhwa (KP) province (Shinwari et al. 2003) where altitudes range from 970 m to 2300 m (Barth 1956), with Falak Sar (the highest peak) towering 5918 m above sea level. The district's climate is dry temperate to moist temperate. Most of the region gets monsoon rains in summer except in the north, which receives very little or no summer monsoon rains (Ali & Qaisar 1986, Ahmad & Sirajuddin 1996). Swat vegetation types range from sub-tropical chir pine (*Pinus roxburghii* Sarg.) forest in the south to alpine pastures and meadows or cold desert in the north (Sher 2013).

Collection and morphological characterization of the basidiomata

Basidiomata were collected, tagged and photographed in the field using a Nikon D70S digital camera. Fresh morphological characters were recorded in the field and colors were designated using Munsell (1975) after which the specimens were dried with the help of a fan heater and sealed in zip-lock bags for long-term preservation. The dried material was vouchered and deposited in the Lahore Herbarium, Department of Botany, University of the Punjab, Pakistan (LAH).

Microscopic characteristics were observed in 5% KOH solution. The abbreviation 'n/b/p' indicates 'n' basidiospores measured from 'b' basidiomata from 'p' collections. Basidiospore dimensions are given as length × width (l × w), with extreme values given in parentheses, and Q = l/w ratio of individual spores; avQ = average Q of all spores ± standard deviation (Zhang et al. 2010).

Isolation and morphological characterization of ectomycorrhizal roots

Twenty 15 cm^3 soil cores near the soil surface were retrieved from each sampling site close enough to *Quercus* tree trunks to ensure that they contained fine *Quercus* roots. Each soil core was later soaked in water in the laboratory for 1–2 hrs and then passed over a 2 mm sieve under running water to separate the roots from soil. Ectomycorrhizal roots were carefully sorted into morphotypes using a Meiji Techno EMZ-5TR stereomicroscope. The fresh ectomycorrhizal roots were cleaned with a fine camel hair brush, photographed under the stereomicroscope, and examined anatomically under a compound microscope. The morphotypes were kept in McCartney bottles in distilled water with replicates of each reserved in 2% CTAB buffer at 8°C for molecular analysis.

DNA extraction, PCR and sequencing

DNA was extracted (from 3–4 gills or 0.5–1 mg of context tissue per basidioma or 2–4 ectomycorrhizal root tips per morphotype) using a modified CTAB method (Bruns 1995). The extracted genomic DNA was evaluated using gel electrophoresis (1% agarose gel in Gel documentation system Uvipro Platinum (IM-2000 WL/LC/26M MANZ) with default settings. After confirmation, genomic DNA was suspended in nuclease free water and stored at 20°C. The target rDNA internal transcribed spacer region (ITS1 + 5.8S + ITS2) was amplified by optimized polymerase chain reaction (PCR) (Gardes & Bruns 1993) using the ITS1F fungal specific forward primer (5′–CTTGGTCATTTAGAGGAAGTAA–3′; Gardes & Bruns 1993), ITS4 reverse primer (5′–TCCTCCGCTTATTGATATGC–3′; White et al. 1990), and Taq polymerase as catalyst in 20 µL PCR tubes using Gene Amp PCR system 9700. The thermo-cycling profile had an initial and final denaturation step at 94°C for 1 minute followed by 30 cycles at 53°C for 1 minute for annealing, and a 1-minute initial extension and 8-minute final extension at 72°C. PCR products were visualized by using 1% agarose gel. Amplified products were sequenced in both directions with the ITS1F and ITS4 amplification primers by BGI Tech Solutions (HK Co. Ltd.). To identify the plant host species, the host plant DNA was extracted from root tips and amplified using the plant specific primer 28KJ (5′–GGCGGTAAATTCCGTCC–3′) and universal primer 28C (5′–GCTATCCTGAGGGAAACTT–3′) (Cullings 1992). Successful amplicons obtained from ectomycorrhizal roots were purified using Exonuclease I and Shrimp Alkaline Phosphatase enzymes (Werle et al. 1994). The purified products were sequenced by the University of Florida's Interdisciplinary Center for Biotechnology Research (http://www. biotech. ufl.edu/). Sequence chromatograms were trimmed, edited, and assembled using Sequencher 4.1 (Gene Codes, Ann Arbor, MI).

Sequence alignment and phylogenetic analysis

Consensus sequences were generated from the obtained sequences with the forward and reverse algorithms in BioEdit (Hall 1999) and then BLAST searched at NCBI (http://www.ncbi.nlm.nih.gov/). Closely matched sequences from GenBank were downloaded for phylogenetic analysis based on BLAST analysis and on sequences generated by previous phylogenetic studies of *Amanita pallidorosea* (Zhang et al. 2010, Kim et al. 2013, Li et al. 2015). Sequences were manually edited and assembled using BioEdit (Hall 1999) and ClustalW (Thompson et al. 1997). All ITS sequences were trimmed with the conserved motifs 5′–(...GAT)CATTA– and –GACCT(CAAA...)–3′ to facilitate alignment, with the the alignment portion between them included in the analysis (Dentinger et al. 2011). These sequences were aligned with other GenBank sequences using the MUSCLE (Edgar 2004) alignment tool available online (www.ebi.ac.uklTools/msalmuscle). In aligned dataset, all characters were equally weighted, and gap positions were treated as missed data. A phylogenetic tree was constructed with the maximum likelihood (ML) analysis using Jukes-Cantor model in MEGA6 software to test the phylogeny (Tamura et al. 2011). All obtained sequences have been submitted to and accessioned by GenBank.

Results

Amanita pallidorosea P. Zhang & Zhu L. Yang,
Fungal Diversity 42: 125 (2010) Figs 1, 2

Basidiomata medium sized. Pileus 40–60 mm diam., convex to plano-convex, slightly umbonate, the disc pale pink (5yr9/4) to pale rose (10r9/6) and becoming white with maturity or under dry conditions; surface dry, smooth, volval remnants sometimes present, dull to shiny, margins smooth, incurved when young becoming straight and splitting with age or in dry conditions; context dry, whitish or slightly paler than cap, 1–3 mm, texture soft, not changing upon cutting or bruising. Odor not distinctive; taste not recorded. Lamellae 4.5 mm broad, free, crowded, whitish at first then turning creamy to yellowish cream (10yr9/8) at maturity, edge entire. Lamellulae attenuate, frequent, length variable. Stipe 80–120 × 6–12 mm, central, cylindrical to sub-cylindrical to tapering upwards, white to creamy white above the annulus and creamy white with a yellowish (10yr9/8) to yellowish pink (10r7/10) tinge below, upper quarter hollow, below solid; surface smooth to finely fibrillose squamulose; context white. Annulus present, membranous, thin, permanent, yellow to white. Volva saccate, white, membranous, permanent, in some specimens breaking to leave fragments on the stipe, giving the stipe a banded appearance.

Basidiospores [n/b/p = 80/4/3] 7–8.5(–9) × (6.5–)7–8.5(–9) µm, Q = 1–1.08, avQ = 1.01, globose to subglobose, apiculus prominent (1.5 µm long), guttulate, amyloid in Melzer's reagent. Basidia 31–40 × 8–10.5 µm, clavate, tetra-sterigmate, basal clamps absent. Pileipellis hyphae 3.5–5(–7.5) µm diam., filamentous, terminal inflated cells clavate 15 µm diam., hyaline; when present, volval remnant cells abundant, inflated (18.5 × 18 µm). Stipitipellis filamentous, hyaline, 4.5–12 µm diam. Volval cells subglobose to oval (66 × 78.5 µm), hyphae 5–7 µm diam. Clamp connections absent in all tissues.

Specimens examined: **PAKISTAN**, **Khyber Pakhtunkhwa Province**, **Swat District**, Lower Shawar, 2100 m asl, on ground in a forest dominated by *Quercus oblongata,* 5 September 2015, Zia-ullah Sh03 (LAH35204; GenBank KY626178); Malam Jabba, Kishawra, 2200 m asl, on soil under oak, 16 August 2015, Junaid Khan MJ1554 (LAH35205; GenBank KY621476); Toa, 2800 m asl, on ground under *Quercus oblongata*, 15 July 2015, Arooj Naseer T4 (LAH35206; GenBank KY616968).

Comments: Macroscopically, *Amanita subpallidorosea* Hai J. Li is strikingly similar to *A. pallidorosea* because of its pale rose pileus with a conspicuous umbo. However, microscopically, *A. subpallidorosea* can be distinguished from *A. pallidorosea* by its larger basidia and basidiospores (Li et al. 2015, Yang 2015). Pure white specimens of *A. pallidorosea,* also common (Zhang et

FIG. 1. *Amanita pallidorosea* basidiomata. A. LAH35204; B. LAH35206; C–F. LAH35205. Scale bars: A = 1.9 cm; B =1.6 cm; C = 0.9 cm; D = 1.1 cm; E = 1.7 cm; F = 1.5 cm.

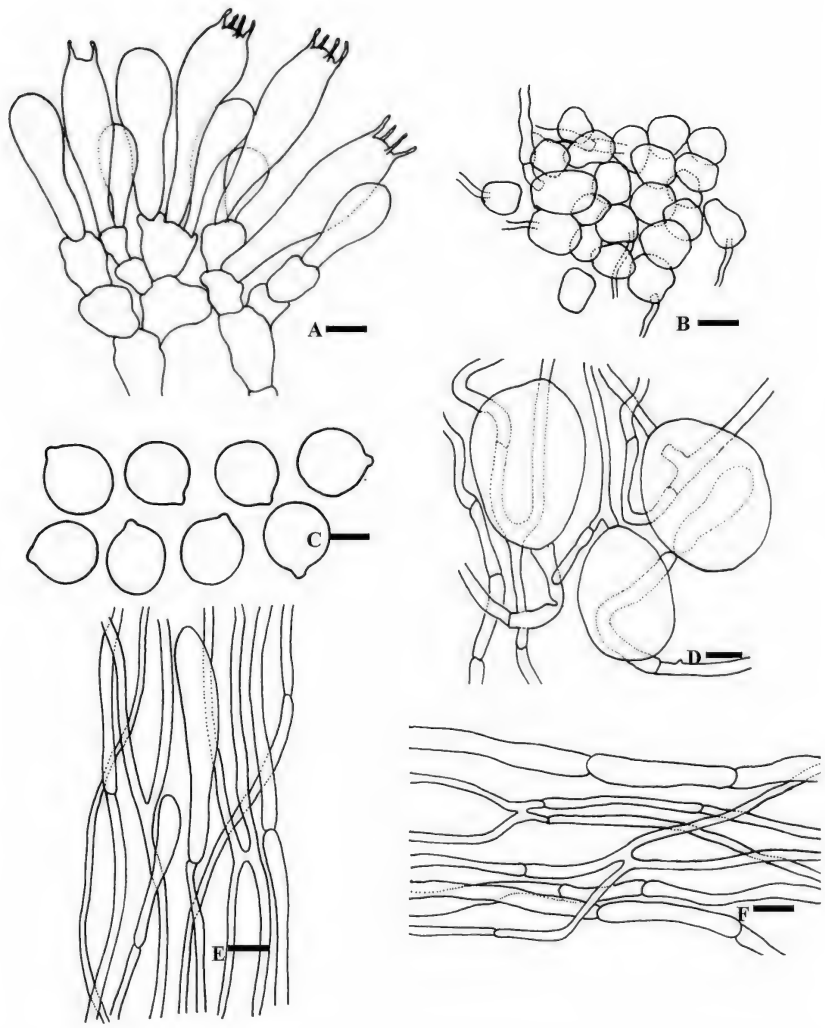

Fig. 2. *Amanita pallidorosea* (LAH35204). A. basidia and subhymenium; B. volval remnants on pileus; C. basidiospores; D. volva; E. pileipellis; F. stipitipellis. Scale bars: A = 7.5μm; B = 30 μm; C = 6.5 μm; D = 25 μm; E, F = 20 μm. Drawings by M. Kiran.

al. 2010, Yang 2015), can be easily confused with *A. virosa* Bertill. (Malysheva et al. 2014). *Amanita virosa,* however, can be distinguished with its distinctly recurved squamules on the stipe and larger basidiospores (Neville & Poumarat 2004, Yang 2015).

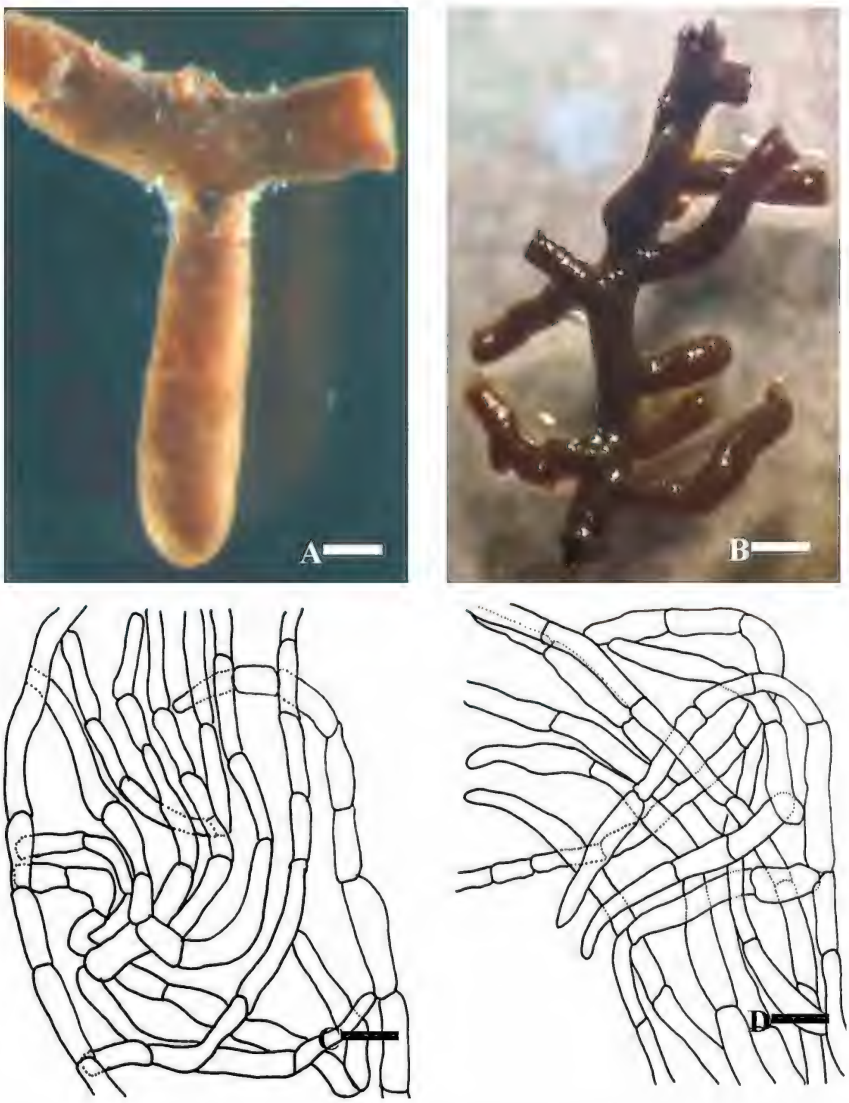

Fig. 3. *Amanita pallidorosea*/*Quercus oblongata* mycorrhiza (LAH-EM64). A, B. ectomycorrhizal roots; C. inner mantle layer cells; D. outer mantle layer cells. Scale bars: A = 0.6 mm; B = 1.2 mm; C = 7.5 μm; D = 10 μm. Drawings by M. Kiran.

Morphological characterization of ectomycorrhizae **Fig. 3**

Ectomycorrhizal system dichotomous, 6–18 mm long, axis ≤1 mm diam., unramified, ends straight, cylindrical, surface smooth, dark brown

(10R1/4). Outer mantle hyphal cells 4.39–5.85 µm diam., loosely arranged. Inner mantle hyphal cells 4.17–4.80 µm compactly arranged. Cells in both layers are mantle type A (Agerer 1987–2002), frequently septate, branched, thin-walled, yellowish brown, end cells not sharply pointed. Emanating hyphae rarely present. Rhizomorphs not observed.

Habitat & distribution: In Pakistan, solitary to scattered in small groups on ground under oak. Originally described from China (Zhang et al. 2010); also known from Japan, Korea, and eastern Russia (Kim et al. 2013, Malysheva et al. 2014, Yang 2015, Cai et al. 2016).

Specimens examined: **PAKISTAN, Khyber Pakhtunkhwa Province, Swat District**, Toa, 2800 m asl, associated with roots of *Quercus oblongata*, 15 July 2015, Arooj Naseer ANT58 (LAH-EM65; GenBank KY616969); 15 July 2015, Arooj Naseer ANT81 (LAH-EM66; GenBank KY616970); 15 July 2015, Arooj Naseer ANT450044 (LAH-EM67; GenBank KY616971); Shawar, 2100 m asl, on roots of *Quercus oblongata,* 14 August 2015, Arooj Naseer AN26 (LAH-EM64; GenBank KY616967).

Molecular phylogenetic characterization

Fig. 4

The host plant sequence (GenBank KY829452) obtained from ectomycorrhizal roots of *Amanita pallidorosea* (GenBank KY616969) showed 99% identity with *Quercus oblongata* D. Don [= *Quercus incana* Roxb., nom. illeg.] (GenBank AY456170) using BLAST search tool at NCBI. Phylogenetic analysis was performed on a 58-sequence ITS dataset of which 57 sequences represented *Amanita* species and one represented the outgroup *Limacella glioderma* (Fr.) Maire [= *L. delicata* (Fr.) Konrad & Maubl.]. The post-alignment dataset included 891 sites, of which 339 were conserved, 489 variable, and 345 parsimony informative. Reliability of the consensus tree was calculated by 1000 bootstrap replications. The phylogenetic tree contained four well supported clades corresponding to four *Amanita* sections: *A.* sect. *Phalloideae*, *A.* sect. *Validae*, *A.* sect. *Lepidella,* and *A.* sect. *Amanita* (Zhang et al. 2010, Cai et al. 2016). Sequences obtained from the Pakistani basidiomata and morphotypes clustered with *A. pallidorosea* in A. sect. *Phalloideae.* This lineage is consistent with the morphological identification.

Discussion

Amanita pallidorosea is one of the lethal amanitas in *A.* sect. *Phalloideae* (Zhang et al. 2010, Malysheva et al. 2014, Yang 2015). First described by Zhang et al. (2010) from China, the species is characterized by typically pale rosy (sometimes white) umbonate pileus and small globose to subglobose basidiospores. This taxon has been reported from other Asian countries

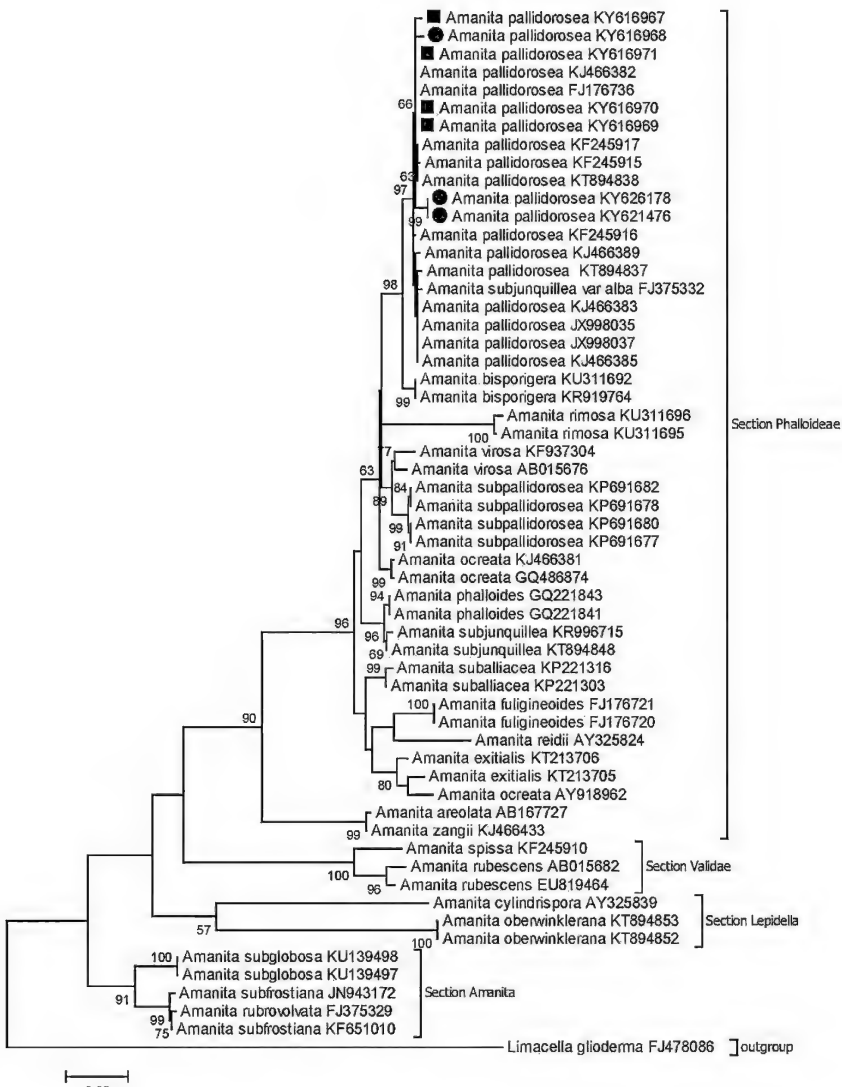

FIG. 4. Molecular phylogenetic analysis of *Amanita* spp. based on ITS sequences. The tree with the highest log likelihood (–5886.3380) is shown. The analysis involved a total of 58 nucleotide sequences and 891 positions in the final dataset. New sequences generated from Pakistani basidiomata are marked with ● and from ectomycorrhizal root tips with ■.

including Japan (Yang 2015, Cai et al. 2016), Korea (Kim et al. 2013, Cho et al. 2015), and Russia (Malysheva et al. 2014). Macro- and microscopically, the three *A. pallidorosea* basidiomata (LAH35204–35206) collected in Pakistan agree with the descriptions by Zhang et al. (2010) and Malysheva et al. (2014). However, the smooth stipe surface in some specimens and the hollow stipe apex contrast with the original description. The yellowish annulus in some collections, although differing from the original collection of Zhang et al. (2010), conforms to the findings of Malysheva et al. (2014) and Yang (2015). *Amanita pallidorosea* has not been previously recorded from Pakistan (Ahmad et al. 1997), and our basidiomata and ectomycorrhizal roots represent the first report of the species from the country. Ectomycorrhizal association of *Amanita muscaria* (L.) Lam., *A. citrina* Pers., and *A. strobiliformis* (Vittad.) Bertill. have been described with various hosts with different ramification patterns (Ingleby et al. 1990, Mleczko 2004, Raidl & Verma 2006)

Phylogenetically, the sequences obtained from ectomycorrhizal roots and basidiomata clustered with *A. pallidorosea* sequences retrieved from GenBank in clade sect. *Phalloideae*, which contained *A. areolata* T. Oda et al., *A. bisporigera* G.F. Atk., *A. exitialis* Zhu L. Yang & T.H. Li, *A. fuligineoides* P. Zhang & Zhu L. Yang, *A. ocreata* Peck, *A. phalloides* (Fr.) Link, *A. reidii* Eicker & Greuning, *A. rimosa* P. Zhang & Zhu L. Yang, *A. suballiacea* (Murrill) Murrill, *A. subjunquillea* S. Imai, *A. subjunquillea* var. *alba* Zhu L. Yang, *A. subpallidorosea*, *A. virosa*, and *A. zangii* Zhu L. Yang et al. (Cai et al. 2014, 2016). Large white basidiomata morphologically similar to *A. pallidorosea* are also present in *A. bisporigera*, *A. exitialis, A. oberwinkleriana* Zhu L. Yang & Yoshim. Doi, *A. ocreata*, *A. subjunquillea* var. *alba*, and *A. virosa* (Imazeki & Hongo 1987, Yang & Li 2001, Malysheva et al. 2014) (Fig. 4).

Amanita pallidorosea has been previously reported from forests dominated by *Quercus mongolica* Fisch. ex Ledeb., and members of family *Fagaceae* and *Pinaceae* (Zhang et al. 2010, Malysheva et al. 2014, Cai et al. 2016), but no studies have been published confirming its ectomycorrhizal association. This appears to be the first report of ectomycorrhizal association of *A. pallidorosea* with *Quercus oblongata* supported by morphological and molecular data.

Acknowledgements

The authors are grateful to Prof. Zhu Liang Yang (Kunming Institute of Botany, Chinese Academy of Sciences, China) for his valuable comments and suggestions to improve the manuscript. Thanks are due to Dr. Sana Jabeen (University of Education, Faisalabad Campus, Pakistan), Dr. Andrew W. Wilson (Denver Botanic Gardens, USA),

and Dr. Yan-Chun Li (Kunming Institute of Botany, Chinese Academy of Sciences, China) for providing helpful reviews of this manuscript. We very much appreciate the field assistance of Dr. Abdul Rehman Khan Niazi (University of the Punjab, Lahore, Pakistan). Sincere thanks are also due to Dr. Matthew E. Smith (University of Florida, USA) for providing molecular research facilities to one of the authors. Thanks are also due to Dr. Shaun Pennycook for his precious time in editing the nomenclature.

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MYCOTAXON

ISSN (print) 0093-4666 (online) 2154-8889 Mycotaxon, Ltd. ©2017

October–December 2017—Volume 132, pp. 813–817

https://doi.org/10.5248/132.813

Ellisembia pseudokaradkensis sp. nov. from Hainan, China

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Abstract—*Ellisembia pseudokaradkensis*, isolated from decaying dicotyledonous leaves submerged in a stream, is described and illustrated as a new species. The fungus is characterized by obclavate conidia with long flagelliform apical appendages. The new taxon is compared with other *Ellisembia* species having flagelliform appendages at the conidial tip.

Key words— aquatic hyphomycetes, fungal diversity, morphology

Introduction

Ellisembia was introduced by Subramanian to accommodate *Sporidesmium*-like species, with *Sporidesmium coronatum* Fuckel [≡ *E. coronata* (Fuckel) Subram.] as type species (Subramanian 1992). The genus is characterized by determinate or irregularly percurrently extending conidiogenous cells that produce distoseptate conidia, while *Sporidesmium* is restricted to those species that have conidiogenous cells without or with irregular proliferation and euseptate conidia (Subramanian 1992). Despite the segregation of a new genus from *Sporidesmium* in 1992, researchers continued to place some species with distoseptate conidia into *Sporidesmium* (Shi & Zhang 2007, Ma & Zhang 2007a,b); these were subsequently transferred into *Ellisembia* (Santa-Izabel et al. 2013). Wu & Zhuang (2005), who merged *Imicles* Shoemaker & Hambl. into *Ellisembia,* expanded the generic concept to include species that produce typically lageniform, ovoid, or doliiform, percurrently extending conidiogenous cells. Currently 60 species are included in *Ellisembia* (Index Fungorum 2017).

Several fungal species and genera occurring on dead stems or decaying branches of broadleaf trees have been described recently in China (Xia et al. 2015, 2016; Ren et al. 2012; Ma et al. 2007a,b, 2010). During a study of aquatic hyphomycetes in Diaoluo Mountain Preserve, Hainan Province, China, we encountered an unknown fungus sharing some features of *Ellisembia* that we propose here as a new species.

Materials & methods

The culture was isolated from decaying leaves collected on a broadleaf tree in Diaoluo Mountain Preserve, Hainan province, in southern China, by Z.F. Yu on April 2015. The decaying leaves were cut into several 2–4 × 2–4 cm sized fragments, which were flattened out on the surface of CMA (20 g cornmeal, 18 g agar, 40 mg streptomycin, 30 mg ampicillin, 1000 ml distilled water) for ten days; single conidia were isolated using a sterilized toothpick while viewing with a CX31 microscope, and cultivated on CMA in Petri plates. Morphological observations were made from CMA after incubation at 28°C for one week; pure cultures and a permanent slide were deposited in the Herbarium of the Laboratory for Conservation and Utilization of Bio-resources, Yunnan University, Kunming, Yunnan, P.R. China (YMF; formerly Key Laboratory of Industrial Microbiology and Fermentation Technology of Yunnan).

Taxonomy

Ellisembia pseudokaradkensis M. Qiao & Z.F. Yu, **sp. nov.** PLATE 1

MycoBank MB 820988

Differs from *Ellisembia karadkensis* by its smaller, unbranched conidia with fewer septa.

TYPE: China, Hainan Province: Diaoluo Mountain Preserve, 18°43′N 109°43′E, elev. 1020 m, on submerged decaying leaves of an unidentified dicotyledonous plant in a stream, July 2015, J. Peng (**Holotype**, YMF 1.04266).

ETYMOLOGY: Latin, *pseudokaradkensis,* referring to the similarity to *E. karadkensis* in the shape of conidia.

COLONIES 2 cm diam. on CMA after 10 days, Mycelium partly superficial and partly immersed in the substratum. CONIDIOPHORES erect, macronematous, mononematous, straight or flexuous, dark to blackish brown, arising from creeping hyphae, 0–1-septate, 7–18 × 4–5 µm, base often specialized to T- or L-shape. CONIDIOGENOUS CELLS monoblastic, integrated, terminal, cylindrical, pale or dark brown, 14–15 × 4.5 µm. Conidial secession schizolytic. CONIDIA solitary, obclavate, mostly curved, tapering towards narrow whip-like apical tip, (81.5–)90.5–138(–149) µm long, 5.5–8 µm diam., truncate, 2.5–4 µm diam. at the base, 8–13-distoseptate, with 2–3 apical cells subhyaline or hyaline with

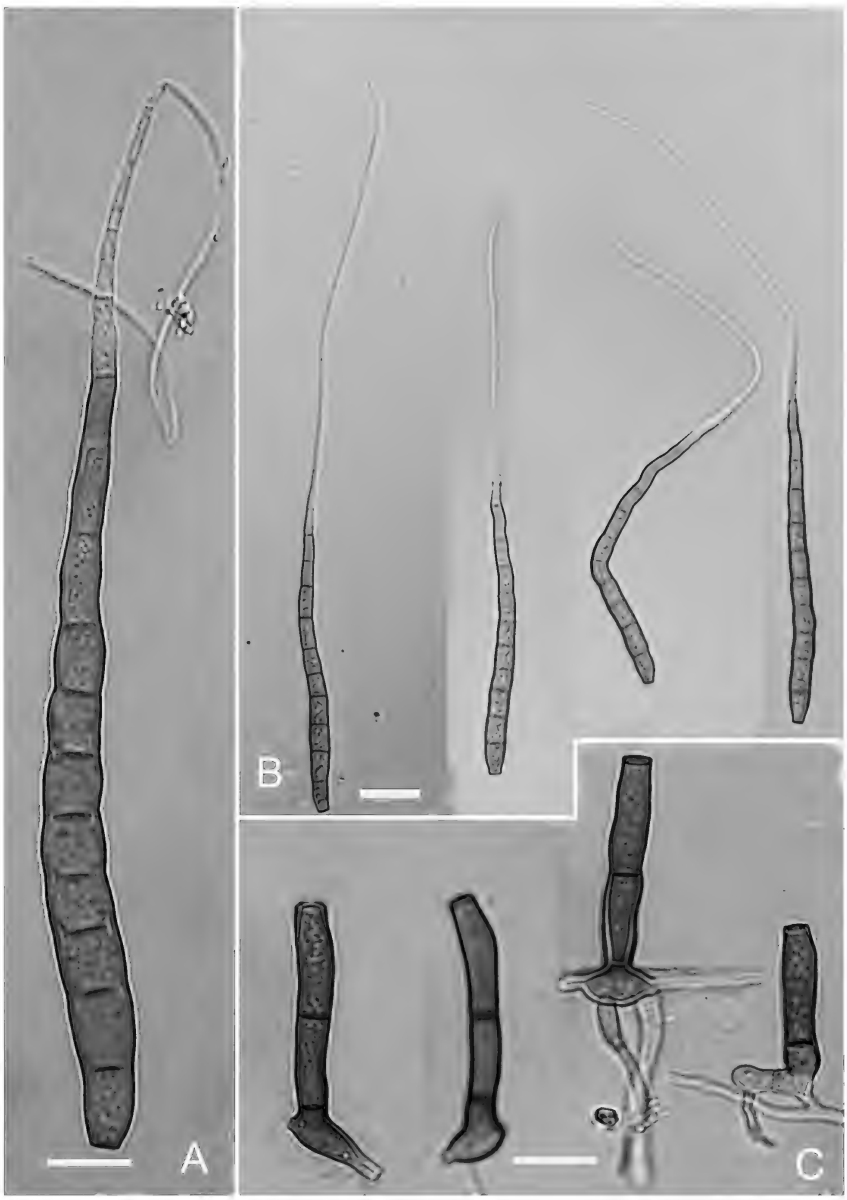

Plate 1. *Ellisembia pseudokaradkensis* (holotype, YMF 1.04266). A. Distoseptate conidium. B. Conidia with flagelliform apical appendages. C. Conidiophores and conidiogenous cells. Scale bars: A, C = 10 μm; B = 20 μm.

thin septa, other cells pale olivaceous to brown but dark at the septa, apical appendages (33–)57–148 µm long, 0.5–1 µm diam.

Discussion

Ellisembia pseudokaradkensis is characterized by flagelliform apical appendages and long, narrow conidia. Five other *Ellisembia* species have flagelliform appendages at the tip of conidia: *E. podocarpi* Jian Ma & X.G. Zhang, *E. photiniae* Jian Ma & X.G. Zhang, *E. flagelliformis* (Matsush.) W.P. Wu, *E. magnibrachypus* (Matsush.) Rajeshk. & S.K. Singh, and *E. karadkensis* Rajeshk. & S.K. Singh. *Ellisembia E. karadkensis* is distinguished from *E. pseudokaradkensis* by its branched conidia and *E. magnibrachypus* by its branched appendages, and *E. pseudokaradkensis* is distinguished from all five species by its distinctive combination of the number of conidial septa, conidial size, and length of apical appendage (Table 1).

Table 1. Comparison of *Ellisembia* species with appendages at the tip of conidia.

Species	Conidia			Reference
	Number of septa	Length × width (µm)	Apical appendage length (µm)	
E. flagelliformis	11–14	60–90 × 9–10	40	Wu & Zhuang (2005)
E. karadkensis	10–35	150–345 × 9.5–12.5	100 *	Rajeshkumar et al. (2012)
E. magnibrachypus	9–10	48–62 × 12–14	65	Matsushima (1975)
E. photiniae	10–16	92–170 × 13–16	43–90	Ma et al. (2010)
E. podocarpi	13–19	110–170 × 7.5–10	80	Ma et al. (2010)
E. pseudokaradkensis	8–16	90.5–138 × 6.0–7.5	(33–)57–148	This paper

* Appendage length estimated from illustration

Acknowledgements

This work was jointly financed by National Natural Science Foundation Program of PR China (31360130, 31770026). We are very grateful to Prof. X.G. Zhang and Dr. R.F. Castañeda-Ruiz for critically reviewing the manuscript and providing helpful suggestions to improve this paper.

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MYCOTAXON

ISSN (print) 0093-4666 (online) 2154-8889 Mycotaxon, Ltd. ©2017

October–December 2017—Volume 132, pp. 819–829

https://doi.org/10.5248/132.819

Colpoma guadueticola sp. nov. in a guadual forest from Quindio Department, Colombia

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Abstract—*Colpoma guadueticola* is described as a new species growing on fallen culms of *Guadua angustifolia* from Colombia. The specimens were collected in a guadual forest from the Natural Reserve 'La Montaña del Ocaso', municipality of Quimbaya, Quindio Department, Colombia. A key to the species of *Colpoma* is presented.

Key words—*Leotiomycetes, Rhytismatales, Rhytismataceae*, taxonomy

Introduction

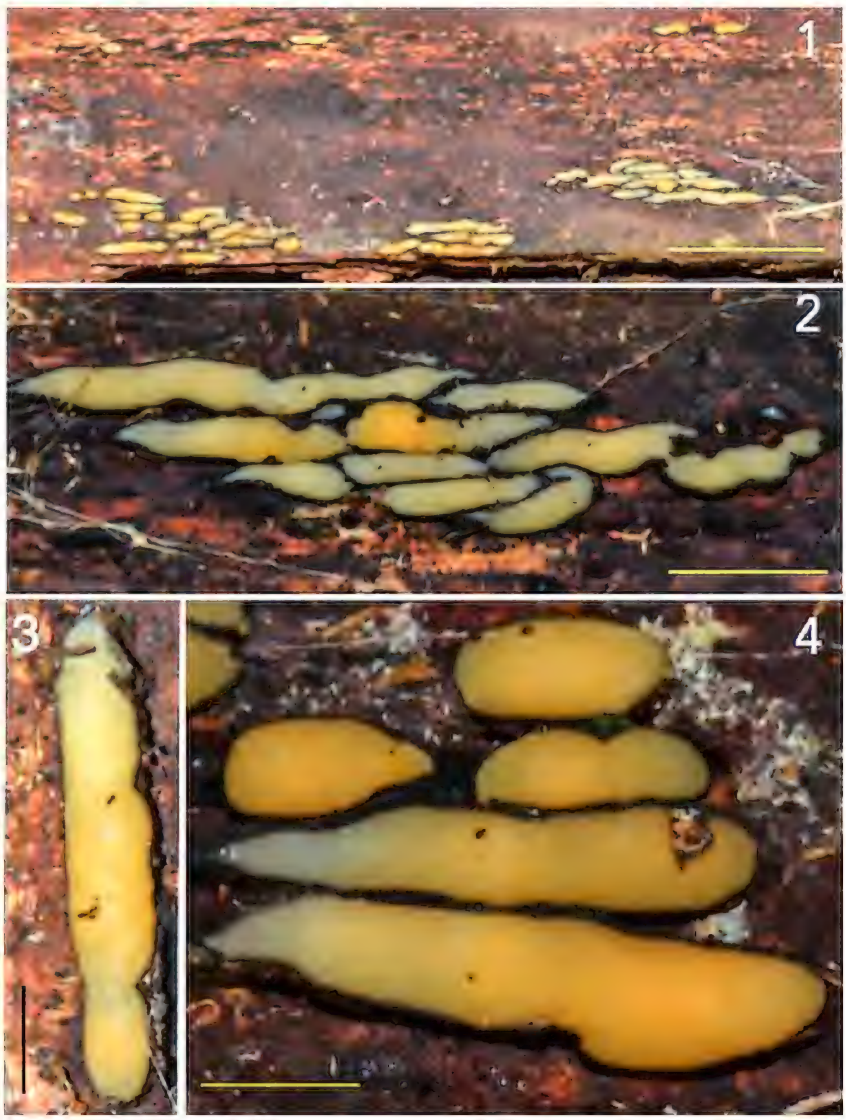
Colpoma was described by Wallroth in 1833 with *C. quercinum* (Pers.) Wallr. as the type species (Darker 1967). The ascomycete genus is characterized by its elongated (often curved) or ellipsoid apothecial ascomata that erupt under periderm or break through naked wood and open with a single longitudinal slit, well developed thick dark colored covering and basal layers, abundant slender paraphyses that often coil or bend at the tip, and continuous cylindric or filiform ascospores (Darker 1967, Johnston 1991). Quélet placed *Colpoma* within *Patellariaceae* (*Hysteriales*), a family later transferred to *Phacidiales* by Saccardo (Theon 1918). Darker (1967) moved *Colpoma* to *Hypodermataceae* (*Phacidiales*) after which Sherwood (1979) and Johnston (1991) transferred the genus to *Rhytismataceae* (*Phacidiales*). Currently, Medardi (2002, 2004) and Kirk et al. (2008) include *Rhytismataceae* within *Rhytismatales*.

The Natural Reserve 'La Montaña del Ocaso' is located at 4°34′08″N 75°51′03″W, south of Quimbaya municipality in Quindio Department, Colombia (Agudelo & Gómez 2001). The guadual forest of this natural reserve is a floristic resource of great ecological importance because of the huge diversity of plants, animals, and fungi. The forest is dominated by *Guadua angustifolia* Kunth (*Poaceae*), known as "Colombian bamboo" and considered the world's third largest bamboo, reaching heights up to 30 meters (Agudelo & Gómez 2001, Moreno et al. 2007).

There are few studies on fungal species associated with *Guadua angustifolia* in Colombia. Restrepo-F. et al. (2005) isolated four agaricomycete genera on *Guadua: Pleurotus* spp., *Schizophyllum commune* Fr., *Daedaleopsis tricolor* (Bull.) Bondartsev & Singer, and *Polyporus* sp. Soto-Agudelo et al. (2016a) described 29 ascomycete species collected in a guadual forest from the Natural Reserve 'La Montaña del Ocaso' from Colombia; of these, 15 grew on decayed debris of *Guadua angustifolia*, ten were found on decayed wood of trees, and four were parasites of other ascomycetes. In 2015 and 2016, during an ongoing survey of *Ascomycetes* in Colombia (Soto-Agudelo et al. 2016a,b), three *Colpoma* specimens were gathered from *Guadua angustifolia*. These collections had a distinct morphotype that could not be satisfactorily accommodated in any of the known species of this genus. The objective of the present work is to describe these specimens as a new species of *Colpoma* associated with *Guadua angustifolia* in the Department of Quindio in Colombia.

Materials & methods

The specimens were collected in The Natural Reserve 'La Montaña del Ocaso'in October 2015 and May 2016 and are deposited in the herbarium of the University of Quindío, Armenia, Colombia (HUQ) and in the fungal collection 'Dr. Gastón Guzmán Huerta' at the Herbarium Escuela Nacional de Ciencias Biológicas of Instituto Politécnico Nacional, Mexico City, Mexico (ENCB). Latitude/longitude coordinates were obtained with GPS eTrex (Garmin). Colors are coded according to Kornerup & Wanscher (1978). Morphological examinations were conducted using protocols outlined by Johnston (1991) and Minter (1997). Anatomical characters were measured from rehydrated tissues in 5% aqueous KOH and Melzer's reagent. Macroscopic characters were photographed with a Nikon D7000 and micrographs were taken with a Nikon Coolpix 9000. The meanings of some terms are based on Ulloa & Hanlin (2012) dictionary.



Figs 1–4: *Colpoma guadueticola* (isotype, ENCB Raymundo 5898). 1. Gregarious linear apothecia on fallen culm. 2. Mature fusiform, curved, sigmoid, sinuous to undulate apothecia with rounded or acute ends. 3. Elongated apothecium with rounded ends. 4. Apothecia ellipsoid, elongated, lacrymoid with rounded or acute ends. Scale bars: 1 = 10 mm; 2 = 3 mm; 3, 4 = 1 mm.

Taxonomy

Colpoma guadueticola Raymundo, Soto-Agudelo & R. Valenz., **sp. nov.** Figs 1–15

MycoBank MB 820664

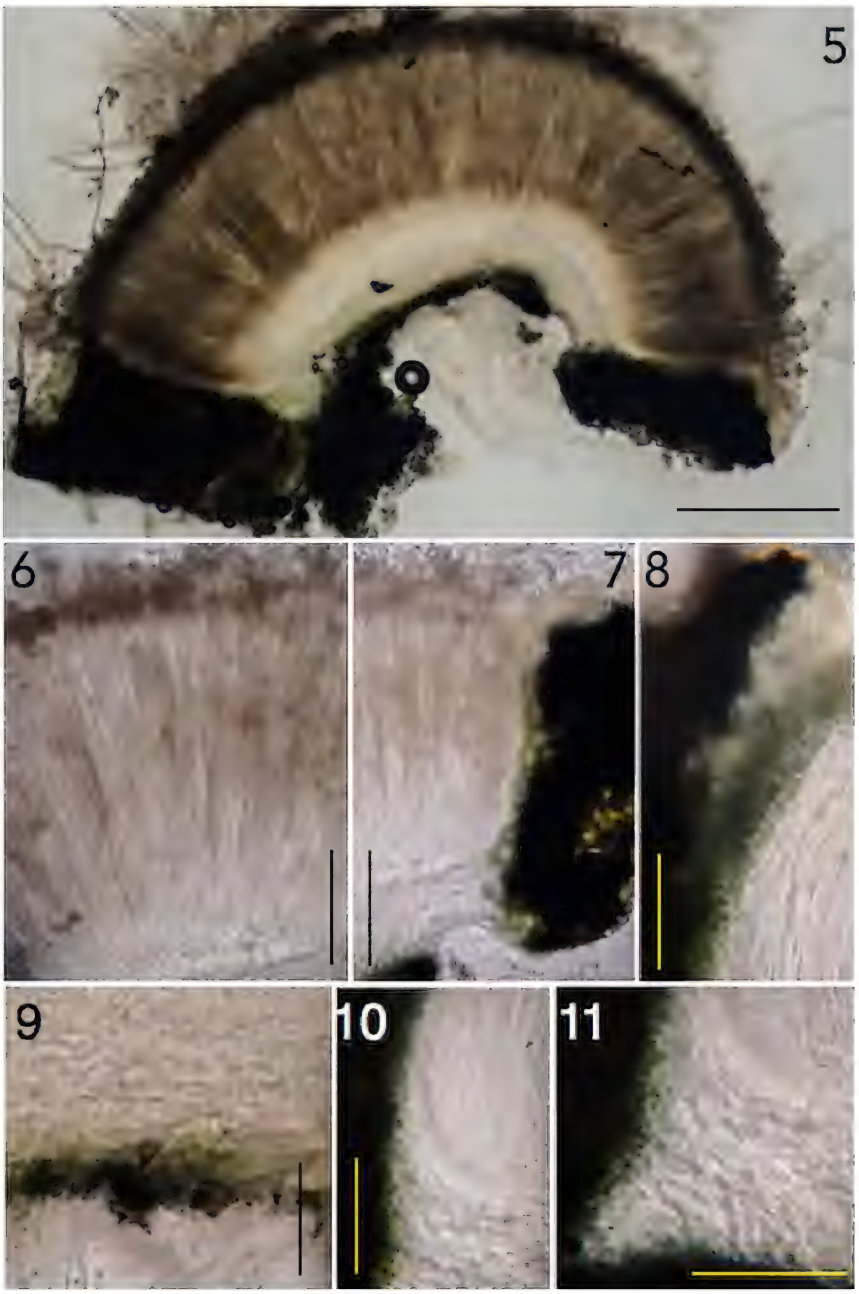
Differs from *Colpoma quercinum* by its long, filiform ascospores, its paraphyses dichotomically to irregularly branched at the apex, and its substrate of fallen culms of *Guadua angustifolia*.

Type: Colombia, Quindio department: municipality of Quimbaya, Natural Reserve 'La Montaña del Ocaso', 4°34′08″N 75°51′03″W, alt. 1050 m, 29 October 2015, T. Raymundo 5898 (**Holotype**, HUQ; **isotype**, ENCB).

Etymology: Referring to *Guaduetum*, the phytosociological name for the guadual forest dominated by *Guadua angustifolia*, where the specimens were collected.

Apothecia (1–)2–10 mm long and 0.4–0.8 mm broad, stromatic, erumpent, deeply immersed within substratum, and aligned with the main axis of the fallen culm; visible initially as small ellipsoid to oblong or linear black spots when closed, later opening by one longitudinal split, variable in shape when mature: ellipsoid, oblong, fusiform, curved, sigmoid, lacrymoid, sinuous to undulate, rounded or acute at both ends; the apothecial wall mostly covered with black stromatic tissue. Hymenium slightly raising the substratum surface, yellowish white (4A2) to pale yellow (4A3) in young specimens or at the edges and ends of the ascomata, light yellow (4A5) to deep yellow (4A8) in mature fresh specimens. Stromatic tissue in vertical transverse section covering the lateral sides and the lower part of the apothecia, lateral walls 60–100 µm thick, forming a textura angularis, dark brown to black in KOH, comprising mostly angular cells, olivaceous green to black, slightly thick-walled 5–9 µm diam.; lower wall 30–40 µm thick, forming a textura angularis, dark brown in KOH, comprising mostly angular cells, olivaceous green to brown, slightly thick-walled, 5–7 µm diam. Medullar excipulum 30–50 µm thick, forming a textura intricata with interwoven hyphae, hyaline in KOH, septate, 1–2 µm diam. Subhymenium 8–12 µm thick, forming a textura intricata, interwoven hyphae hyaline in KOH, 1–2 µm diam. Paraphyses filiform, hyaline in KOH, non-septate, smooth, thin walled, dichotomously to irregularly branched at the apex, extending up to 20 µm beyond the asci, 1–2 µm diam. Asci 136–180 × 5–7 µm, cylindrical,

Figs 5–11: *Colpoma guadueticola* (isotype, ENCB Raymundo 5898). 5. Apothecium, vertical transverse section. 6. Hymenium. 7. Medullary excipulum, hymenium, and stromatic tissue. 8. Lateral stromatic tissue with textura angularis. 9. Basal stromatic tissue. 10–11. Basal and lateral stromatic tissue and medullary excipulum. Scale bars: 5 = 300 µm; 6 = 80 µm; 7 = 100 µm; 8 = 40 µm; 9, 10 = 50 µm; 11 = 20 µm.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8-spored, hyaline in KOH, uniformly thin-walled, with only one wall layer visible, rounded apex, inamyloid. Ascospores parallel to subparallel within the ascus, (68–)80–110(–120) × 0.8–1.0 µm, filiform, straight to slightly curved, hyaline in KOH, aseptate, thin-walled, smooth, gelatinous sheath not observed at the apex.

Ecology & distribution—Gregarious on fallen and dead culms of *Guadua angustifolia* in guadual forest mixed with tropical dry forest. The species is known only from the type locality.

Additional specimens examined—**COLOMBIA, Quindio department: Municipality of Quimbaya,** Natural Reserve 'La Montaña del Ocaso', 4°34′08″N 75°51′03″W, alt. 1050 m, 29 October 2015, R. Soto-Agudelo 60 (HUQ); 17 May 2016, T. Raymundo 6036 (HUQ).

Comments—*Colpoma guadueticola* is characterized by its variably shaped apothecia with pointed or rounded ends, yellow hymenium, paraphyses that are dichotomously to irregularly branched at the apex, long straight to slightly curved aseptate ascospores, and its host *Guadua angustifolia*.

Colpoma azaleae (Schwein.) Cooke, *C. morbidum* (Peck) Sacc., *C. quercinum,* and *C. styriacum* Remler resemble *C. guadueticola* in having ascospores longer than 70 µm, but *C. azaleae* is separated by its small (1–3 mm long) apothecium, dark subrufescent hymenium, and *Rhododendron periclymenoides* (*Ericaceae*) substrate; *C. morbidum* is distinguished by its white to gray hymenial surface and growth on *Picea mariana* (*Pinaceae*) and *Chamaecyparis thyoides* (*Cupressaceae*); *C. quercinum* has roughly circular to oblong apothecia, apices of the paraphyses developing curls and spirals, and growth on *Quercus* spp.; and *C. styriacum* is separated by its small oblong yellowish green apothecia, 7–8-septate ascospores, and growth on *Vaccinium myrtilloides* (*Ericaceae*). The other *Colpoma* species are separated by their shorter (≤75 µm) ascospores and different hosts, as shown in the key below.

Key to the species of *Colpoma*

1. Ascospores ellipsoid to oblong-elliptical, 5–10 µm diam., 0–3-septate 2
1. Ascospores filiform, 1–3 µm, diam., 0–8-septate 3

2. On fallen bark of *Agathis australis*
(apothecia 0.6–1 × 0.3–0.5 mm, broad ellipsoid to oval, hymenial surface

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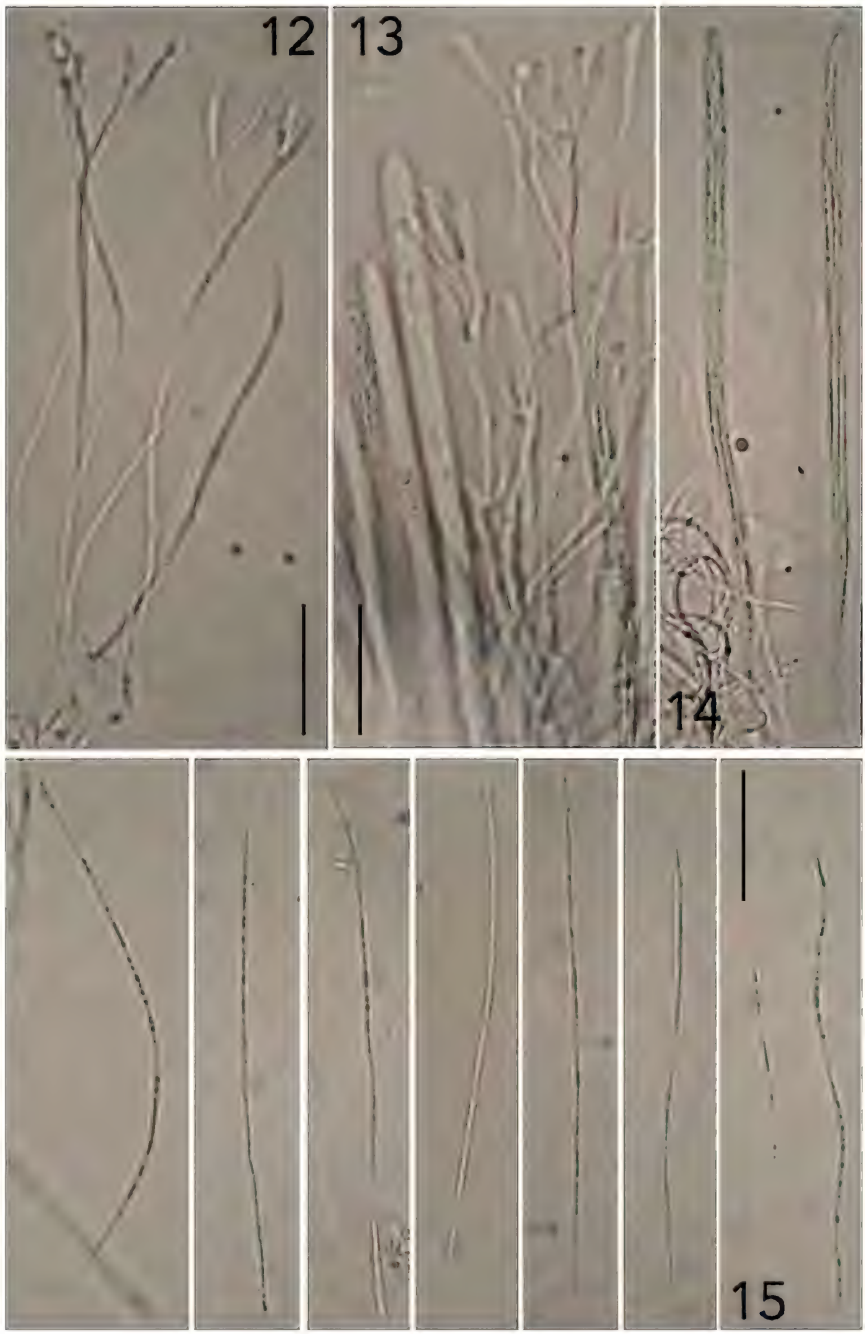
Figs 12–15: *Colpoma guadueticola* (isotype, ENCB Raymundo 5898). 12. Paraphyses dichotomously to irregularly branched at the apex. 13. Asci and paraphyses. 14. Asci with parallel to subparallel ascospores. 15. Ascospores. Scale bars: 12, 14 = 30 µm; 13, 15 = 25 µm.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yellow to orange, ascospores 17–25 × 5–7.5 µm, ellipsoid, (0–)1 septate; known only from New Zealand; Johnston 1991: 405) ..... ***C. agathidis***

2. On fallen wood of *Nothofagus*
(apothecia 1.5–5 × 1–2.5 mm, ellipsoid to irregular in shape, hymenial surface translucent yellow, ascospores 31–46 × 6–10 µm, ellipsoid, (0–)3-septate; known only from New Zealand; Johnston 1991: 407) .. ***C. nothofagi***

3. Ascospores ≤75 µm long 4

3. Ascospores >75 µm **14**

4. On conifers 5

4. On angiosperms **10**

5. On *Cupressaceae*
(on living and dead branches of *Juniperus communis*, apothecia 1–3 × 1–2 mm, circular, ellipsoid to irregular in shape, hymenial surface pale gray to fawn, ascospores 40–50 × 1–2 µm, almost straight, aseptate; European species; Minter 1996a: 1) ..... ***C. juniperi***

5. On *Pinaceae* 6

6. Paraphyses unbranched, straight, slightly swollen at the apex
(apothecia small, 0.6–1 × 0.28–0.4 mm, long ellipsoid, round or acute at each end, hymenial surface gray to dark gray, ascospores 33–53 × 2.5–3.5 µm, fili-fusiform, 3-septate at maturity; known only from China on dead or senescent twigs of *Pinus armandii;* Hou & Piepenbring 2005: 360) .. ***C. intermedium***

6. Paraphyses unbranched or branched, not swollen at the apex
(circinate or flexuous with hooked tips, apothecia larger than 1 mm) 7

7. Apothecia with crenulate margin
(1–2 × 0.5–0.75 mm, ellipsoid, subglobose to irregularly oblong and flexuous, hymenial surface grayish blue to violaceus gray, ascospores 70–75 × 2 µm, almost straight, rounded apex and basal end acute, aseptate; known only from Sweden on fallen twigs of *Pinus sylvestris;* Saccardo 1891: 1128) .. ***C. serrulatum***

7. Apothecia with smooth, striate or rugose margin 8

8. Paraphyses branched, circinate
(apothecia 1–4 × 0.7–1 mm, ellipsoid to linear, hymenial surface pale yellowish gray, ascospores 30–45 × 1.5–2 µm, aseptate; known only from USA on decorticated conifer wood; Sherwood 1979: 35) ..... ***C. deustum***

8. Paraphyses unbranched, flexuous with hooked tips 9

9. Apothecia 0.7–3 × 0.4–1 mm, sometimes curved or irregularly branched, hymenial surface grayish to bluish gray (ascospores 26–42 × 1.5–2 µm, rod-shaped to filiform, aseptate; European species, growing on fallen twigs of *Picea abies;* Minter 1997: 1) ..... ***C. crispum***

9. Apothecia 2–3 mm long, oblong to linear, flexuous, black, (ascospores 25–35 × 1–1.5 µm, subfiliform, rounded apex and acute base, aseptate; known only from Sweden, growing on bark of fallen twigs of *Picea abies;* Saccardo 1891: 1127) ..... ***C. pseudographioides***

10. Apothecia with milk white hymenial surface
(ascospores 50–75 µm long, filiform; known only from North America on dead branches of *Rhododendron groenlandicum;* Peck 1876: 69, Saccardo 1883: 804) ..... ***C. lacteum***

10. Apothecia with gray, bluish gray or grayish blue hymenial surface **11**

11. Paraphyses unbranched, straight to flexuous, apex not differentiated, apothecia small, ≤1.5 mm long **12**

11. Paraphyses unbranched or branched, coiled or convoluted at the apex, apothecia >2 mm **13**

12. Apothecia, 0.7–1.2 × 0.4–0.6 mm ellipsoid to almost circular
(paraphyses straight, ascospores 35–62 × 2–3 µm, fili-fusiform, tapering towards the base, aseptate; known only from China on dead or senescent twigs of *Rhododendron* sp.; Hou & Piepenbring 2005: 363) ..... ***C. sinense***

12. Apothecia 0.5–1.5 × 0.25–0.35 mm, oblong
(paraphyses straight to flexuous, ascospores 35–70 × 1.5–2 µm, filiform, straight to slightly curved, aseptate; known only from China on dead branches of *Rosa* sp.; Trotter 1972: 458 as *Lophodermium rosae* Teng) ..... ***C. rosae***

13. Apothecia small (0.5–5 × 0.4–1 mm)
(elliptical to oblong elliptical, aligned with the main axis of the substratum, ascospores 33–55 × 1–2 µm, almost straight, aseptate; European species, on dead attached twigs of *Rhododendron tomentosum;* Minter 1996b: 1) ..... ***C. ledi***

13. Apothecia much larger (30–35 × 2–3 mm)
(irregularly oblong, tubular, curved, sigmoid, sometimes also with bifurcations, ascospores 60–75 × 1–1.5 µm, slightly curved, aseptate; known only from Italy on dead attached twigs of *Castanea;* Medardi 2004: 36) ..... ***C. caesium***

14. On dead wood of conifers,
(apothecia ellipsoid, oblong to orbicular, white to gray in hymenial surface, ascospores 75–100 × 1.5 µm, filiform, only known from boreal America on *Picea mariana* and *Chamaecyparis thyoides;* Saccardo 1883: 803, Ellis & Everhart 1892: 723 as *Clithris morbida* (Pk.) Ellis & Everhart) ..... ***C. morbidum***

14. On angiosperms **15**

15. Paraphyses dichotomously to irregularly branched at the apex
(apothecia 2–10 × 0.4–0.8 mm, ellipsoid, oblong, fusiform, curved, sigmoid, lacrymoid, sinuous to undulate, round or acute at both ends, hymenial surface light yellow to deep yellow, on fallen and dead culms of *Guadua angustifolia* ..... ***C. guadueticola***

15. Paraphyses unbranched, circinate or coiled at the apex **16**

16. On *Fagaceae* and living/dead branches of *Quercus* spp.
(apothecia 2–15 × 0.5–3 mm, fusiform, navicular to curved, flexuous, hymenial surface yellow, greenish yellow to olivaceous yellow, ascospores 70–95 × 1–3 µm, slightly curved, multiseptate, paraphyses curled to coiled, hooked; European species; Saccardo 1883: 722, Dennis 1981: 226) .... ***C. quercinum***

16. On *Ericaceae* **17**

17. On dead bark of *Rhododendron periclymenoides*
(apothecia 1–3 mm long, linear to elongate, flexuous, hymenial surface dark red, ascospores 90 × 2 µm, filiform, aseptate).
Known only from boreal America (Cooke 1889: 58, Saccardo 1891: 1128, Ellis & Everhart 1892: 722 as *Clithris*) ..... ***C. azaleae***

17. On fallen dead twigs of *Vaccinium myrtilloides*
(apothecia 1–2 × 0.6–1 mm, elongate, hymenial surface translucent yellowish green, ascospores 64–91 × 2–3 µm, sigmoid, attenuated base, 7–8 septate).
Known only from Austria (Remler 1980: 173) ..... ***C. styriacum***

Acknowledgments

We wish to express our gratitude to Dr. Peter R. Johnston and Dr. Martín Esqueda for their useful comments and manuscript review. The authors thank the authorities of Natural Reserve "La montaña del Ocaso" and University of Quindio for the support and facilities to carry out the present study. Tania Raymundo thanks IPN for financial research support in the projects SIP-20161166 and SIP-20170846. Ricardo Valenzuela thanks COFAA and IPN for financial research support in the projects SIP-20161164 and SIP-20170845.

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MYCOTAXON

ISSN (print) 0093-4666 (online) 2154-8889 Mycotaxon, Ltd. ©2017

October–December 2017—Volume 132, pp. 831–837

https://doi.org/10.5248/132.831

Baeomyces lotiformis sp. nov. from China

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Abstract—A new species of lichenized fungus, *Baeomyces lotiformis*, is described and illustrated. It is distinguished by its short podetia and wide apothecium discs, and its affinity was confirmed by ITS sequence analysis.

Key words—*Ascomycota*, *Baeomycetaceae*, chemistry, molecular systematics, morphology

Introduction

The worldwide lichen genus *Baeomyces* Pers. is known from eight crustose to squamulose species with dark red to brownish stiped apothecia containing stictic acid as a major secondary substance (Asahina 1943, Upreti 1985, Gierl & Kalb 1993, Ihlen 1997, Aptroot & Seaward 1999, Kirk et al. 2008). In Yunnan we encountered an undescribed species that showed affinities with this genus but deviated conspicuously by its confluent lotus-like apothecia on very short stipes. Here we present our analysis of the morphology, anatomy, chemistry, and phylogeny of this species to clarify its taxonomy.

Materials & methods

The material used in this study was collected in 2012 in Yunnan province, China. The collections examined are preserved in the Lichen Section of the Botanical Herbarium,

Table 1. nrDNA ITS sequences used in the phylogenetic analysis

Species	Locality	GenBank No.
Ainoa mooreana	Sweden	KJ462262
	Japan	KJ462263
Anamylopsora pulcherrima	Buryatia Republic, Russia	KR017064
	—	AF274089
Baeomyces lotiformis	**Yunnan, China**	**KT597690**
Baeomyces placophyllus	China	DQ001274
	Xizang, China	**KT601493**
Baeomyces rufus	**Yunnan, China**	**KT601494**
	France	AF448458
Parainoa subconcolor	Yunnan, China	KR017133
Phyllobaeis crustacea	Hainan, China	KC414617
	Hainan, China	KC414618
Phyllobaeis imbricata	Ecuador	KC414619
	—	HQ650635
Placopsis contortuplicata	Antarctica	DQ534479
	Antarctica	**KT601492**
Placopsis macrophthalma	Kerguelen	AY212820
Trapelia placodioides	—	KT695380
Trapelia thieleana	—	KU672616
Trapeliopsis flexuosa	—	HQ650634
Trapeliopsis glaucolepidea	—	AY600082

*New sequences are marked in **bold** font; missing data are indicated with "—".

Shandong Normal University, Jinan, China (SDNU). A Zeiss Axioskop 2 plus compound microscope and Motic SMZ-168 dissecting microscope were used to study the anatomy and morphology. A 10% KOH solution, a 5% NaOCl bleaching solution, concentrated alcoholic *p*-phenylenediamine (PD), Lugol's Iodine solution, and thin-layer chromatography (TLC) (Culberson & Kristinsson 1970, Culberson 1972, White & James 1985) were used to detect lichen substances.

DNA extraction, PCR amplification, and sequencing

Total DNA was extracted using a modified CTAB method (Cao et al. 2013). PCR amplifications were performed using a Biometra T-Gradient thermal cycler. The nrDNA ITS region was amplified by the primer pair ITS5 and ITS4 (White et al. 1990). The 50-µl reaction volume comprised 1 µl total DNA, 2 µl of each primer (10 µM), 1 µl Taq polymerase (rTaq DNA Polymerase, 5 U/µl), 4 µl dNTP (2.5 mM each), 5 µl amplification buffer (10×, 25 mM $MgCl_2$ contained), and 35 µl ddH_2O. Cycling parameters included initial denaturation at 95°C for 5 min, 30 cycles of denaturation at 94°C for 40 s, annealing at 52°C for 40 s, extension at 72°C for 2 min, and a final extension at 72°C for 10 min. A negative control, without DNA template, was prepared in every amplification series so as to minimize the possibility of contamination.

PCR products were purified using a Biocolor gel purification kit (BioScience & Technology Co. Ltd.) and sequenced using an ABI 3730 XL DNA Sequencer.

Four nrDNA ITS sequences, including one from the new species, were obtained by the authors, and another 17 nrDNA ITS sequences representing six species were downloaded from GenBank (Table 1). Three sequences from *Placopsis* (*Trapeliaceae*), two from *Trapelia* (*Trapeliaceae*) and two from *Trapeliopsis* (*Trapeliaceae*) were selected as outgroup.

Phylogenetic analysis

The sequences were aligned using ClustalW 1.6 (Thompson et al. 1994). The phylogenetic analysis was executed with software Mega 7 (Kumar et al. 2016). The Kimura-2-parameter was selected as the nucleotide substitution model, and gaps or missing data were set as pairwise deletion. The neighbor-joining (NJ) method was used in constructing the phylogenetic tree and the reliability of the inferred tree was tested by 1000 bootstrap replications.

Result and discussion

The NJ-tree (Fig. 1) of the ITS rDNA sequences clearly supports the genera *Baeomyces*, *Phyllobaeis*, *Parainoa*, *Ainoa*, and *Anamylopsora* in *Baeomycetaceae* as sister branches. The bootstrap values were 98% for *Baeomyces* and 97% for *Phyllobaeis*. *Baeomyces lotiformis* clustered within the *Baeomyces* branch, but was clearly separated from *B. placophyllus* and *B. rufus*.

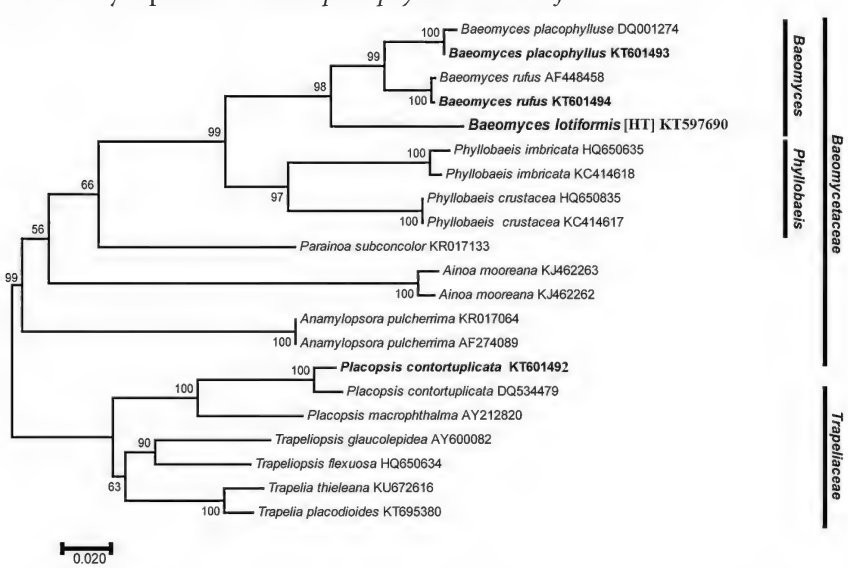

Fig. 1. Neighbor-joining tree of the nrDNA ITS region sequences. Nucleotide: K2 model, gaps or missing data were partial deletion, bootstrap = 1000. Genetic distance scale = 0.02. Numbers at nodes present the bootstrap support value (numbers <50 not shown). New sequences are set in bold font; holotype sequence indicated by '[HT]'.

Taxonomy

Baeomyces lotiformis S.N. Cao, **sp. nov.** FIG. 2

MycoBank MB 819009

Differs from the other *Baeomyces* species by its confluent, lotus-like apothecia and crustose thallus.

Type: China, Yunnan: Jianchuan County, 26°23'N 100°49.8'E, alt. 2665 m, on soil, 25 Nov. 2012, H. Y. Wang yn013 (**Holotype**, SDNU 20160915; GenBank KT597690).

Etymology: Latin *lotiformis*, referring to the lotus-like apothecia. The Latin noun "lotus" has the compounding form "lot–"; and the suffix indicating a morphological similarity is "–formis".

Thallus crustose, gray green to ochre, tightly attached to the substrate, lacking a cortical layer, irregularly delimited; surface irregular with many small, mammillary warts, 0.2 mm in diameter; algae layer continuous, algal cells green, ovoid or ellipsoid, 9–11 × 10–13 µm.

Apothecia dark red to reddish brown, scattered over the thallus, when full-grown with very sinuous margins deeply dividing the disc, which is thus seemingly composed of many confluent discs aggregated into a lotus-like structure, about 2 mm in diameter, when young rounded and 0.5 mm in diameter; disc flattened with swollen margin; podetia very short, less than 1 mm, with nearly sessile apothecia, lacking algae; hymenium 162.5–175 µm thick, algae not observed within subhymenium and exciple, I–; paraphyses branched, not septate; asci long-clavate, 8-spored, with apex I–, 75–90 × 7.5 µm; ascospores oblong or fusiform, hyaline, simple, 8–10 × 5 µm (10 spores observed).

Chemistry—Spot tests: Thallus K+ yellow, C–. Specimen contains stictic acid (TLC).

Additional material examined: **China**, **Yunnan**: Mt. Ailao, 24°21′N 102°31.2′E, alt. 2300 m, on rock, 25 November 2010, H.Y. Wang yn076 (SDNU 20160916).

Comments: *Baeomyces lotiformis* is characterized by a crustose thallus and dark red to reddish brown apothecia with very short podetia, which show affinities with the well-known stiped crustose to squamulose lichen genera *Baeomyces*, *Dibaeis* Clements, and *Phyllobaeis* Kalb & Gierl. However, the new species differs chemically from *Dibaeis* and *Phyllobaeis:* stictic acid is the main substance, and baeomycesic and norstictic acid are absent. The morphological and chemical characters support inclusion of *B. lotiformis* in *Baeomyces*, but within this genus its confluent, lotus-like apothecia are unique.

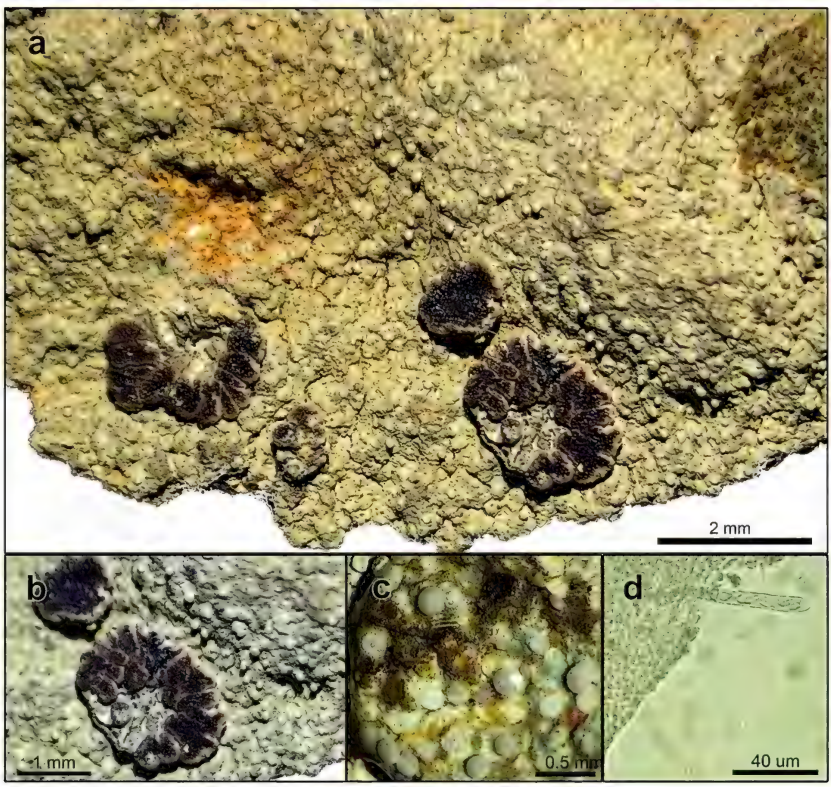

FIG. 2. *Baeomyces lotiformis* (holotype, SDNU 20160915). a, habit; b, apothecia; c, granular mammillary warts (in water); d, asci.

In view of its very short podetia, we compared *B. lotiformis* with the crustose lichen genera also currently included in *Baeomycetaceae: Ainoa* Lumbsch & I. Schmitt, *Anamylopsora* Timdal, and *Parainoa* Resl & T. Sprib. (Lücking et al. 2016). *Ainoa* differs by its dark-brown exciple, narrowly ellipsoid ascospores (16–32× 6–14 µm), and by the presence of gyrophoric acid restricted to apothecia and pycnidia (Brodo & Lendemer 2015). *Parainoa* is similar to *Ainoa* but differs in containing depsidones (like *Baeomyces*); however, *Parainoa* completely lacks a differentiated and extended hypothecial stalk, its hypothecium is yellowish, its thallus is creamish white, its ascomata may or may not contain gyrophoric acid, and it is characterized by simple, roundish apothecia (Resl et al. 2015). *Anamylopsora* is still more distinct by

its squamulose thallus, its black sessile apothecia, its subspherical ascospores, and the presence of alectorialic acid (Timdal 1991).

Our ITS rDNA sequence analysis clusters *B. lotiformis* with *B. rufus* and *B. placophyllus* on a well-supported branch and support *B. lotiformis* as a new species in the genus *Baeomyces*.

Acknowledgments

Our thanks are due in the first place to the Chinese Arctic and Antarctic Administration (2011GW12016). Our project was financially supported by the Program for Scientific Research Innovation Team in Colleges and Universities of Shandong Province, the National Natural Science Foundation of China (31270059), the Science Foundation of Jinan (201202024), and the National innovation Fund for college students (201310445082). We thank Prof. Jae-Seoun Hur, Prof. Sergey Kondratyuk, and Dr. Harrie Sipman for presubmission reviews. We also thank Dr. Shaun Pennycook for valuable comments and nomenclature reviews.

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MYCOTAXON

ISSN (print) 0093-4666 (online) 2154-8889 Mycotaxon, Ltd. ©2017

October–December 2017—Volume 132, pp. 839–847

https://doi.org/10.5248/132.839

Lirula sichuanensis sp. nov. on *Picea likiangensis* var. *rubescens* from Sichuan, China

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Abstract—*Lirula sichuanensis* on 2-year-old dead needles attached on living twigs of *Picea likiangensis* var. *rubescens* [= *P. likiangensis* var. *balfouriana*] in Sichuan Province is described and illustrated as a new species. Phylogenetic analysis based on the internal transcribed spacer sequences of ribosomal DNA sequences confirms its distinction from similar species of the genus. The type specimen is deposited in the Forest Protection Laboratory of Sichuan Agricultural University, China (SAUF).

Key words—*Rhytismataceae*, needle blight, taxonomy, ITS rDNA

Introduction

Lirula Darker is distinguished from other genera of *Rhytismataceae* by its nervisequious ascomata and ascospore shape (Darker 1967). Initially, six species were recombined in *Lirula* by Darker (1967): *L. abietis-concoloris* (Mayr) Darker, *L. macrospora* (R. Hartig) Darker, *L. mirabilis* (Darker) Darker, *L. nervata* (Darker) Darker, *L. nervisequa* (DC.) Darker, and *L. punctata* (Darker) Darker. Ziller (1969) described a new species, *L. brevispora* Ziller on *Picea glauca* (Moench) Voss from Canada. Kaneko (1993) described *L. pakistanensis* S. Kaneko on *Abies pindrow* (Royle ex D. Don) Royle from Pakistan and later (Kaneko 2003) described *L. exigua* S. Kaneko and *L. japonica*

S. Kaneko on *Abies mariesii* Mast. from Japan. Fan et al. (2012) described *L. yunnanensis* L. Fan et al. on *Abies georgei* Orr [≡ *A. forrestii* var. *georgei* (Orr) Farjon] from Yunnan Province, China.

The eleven *Lirula* species usually cause severe needle blight on conifers; two species parasitize *Picea*, and the others mainly *Abies* (Table 1). In this paper, we report a new species of *Lirula* on dead needles of *Picea likiangensis* var. *rubescens* [= *P. likiangensis* var. *balfouriana* (Rehder & E.H. Wilson) Hillier].

Materials & methods

Mature fruitbodies were selected and examined macroscopically under a dissecting microscope at 6–45× magnification and microscopically under a compound microscope at 40–100× magnification (objective lens). The fruitbodies were sectioned by hand; vertical sections were mounted in water for observation of ascomatal and conidiomatal outlines. Gelatinous sheaths surrounding ascospores and paraphyses were examined in water or cotton blue lactophenol. The colours of anatomical structures and ascospore contents were observed in water. All measurements were made using material mounted in water.

Total genomic DNA was extracted from ascomata following the operations manual of DNA extraction kit™ (Tiangen, China). The internal transcribed spacer sequences of ribosomal DNA (ITS rDNA) region were amplified with PCR using the primers ITS1/ITS4 (White et al. 1990). PCR was performed in 50-μL reactions including DNA template 5 μL, primer ITS1/ITS4 2 μL, 2× MasterMix 25 μL, and ddH_2O 16 μL, under the following parameters: 95 °C for 1 min., 50 °C for 1 min., 72 °C for 1 min., for a total

Table 1. Hosts of *Lirula* species.

Species	Host	Reference
L. abietis-concoloris	*Abies concolor*	Darker 1967; Scharpf 1988
L. brevispora	*Picea glauca*	Ziller 1969
L. exigua	*Abies mariesii*, *A. georgei*	Kaneko 2003; Fan et al. 2012
L. japonica	*Abies mariesii*	Kaneko 2003; Fan et al. 2012
L. macrospora	*Picea likiangensis* var. *rubescens*, *P. wilsonii*, *Picea asperata*, *P. crassifolia*, *P. jezoensis*, *P. koraiensis*, *P. neoveitchii*, *P. schrenkiana*, *P. abies*, *P. glauca*, *P. pungens*	Darker 1932; Darker 1967; Lin et al. 2012; Scharpf 1988
L. mirabilis	*Abies balsamea*	Darker 1967
L. nervata	*Abies balsamea*	Darker 1967
L. nervisequa	*Abies alba*, *A. fabri*, *A. fargesii*, *A. holophylla*, *A. forrestii* var. *smithii*, *Taxus wallichiana*	Darker 1967; Lin et al. 2012; Fan et al. 2012
L. pakistanensis	*Abies pindrow*	Kaneko 1993
L. punctata	*Abies amabilis*, *A. balsamea*, *A. concolor*, *A. grandis*, *A. procera*, *A. mariesii*	Darker 1967
L. yunnanensis	*Abies georgei*	Fan et al. 2012

of 35 cycles followed by a final extension step at 72 °C for 5 min. The PCR products detected by gel electrophoresis were sent to Invitrogen Biotechnology (Guangzhou, China) for purification and sequencing.

The ITS rDNA sequences were aligned with ClustalW 1.8 (Thompson et al. 1997); sections of the sequences longer than the sequence of new species were excluded from the analysis. A neighbor-joining (NJ) tree was generated with MEGA5.1 software (Tamura et al. 2011), and branch stability was estimated with 1000 bootstrap pseudo-replicates calculated with Kimura's two-parameter model (Kimura 1980). Other ITS rDNA sequences used in this study were downloaded from GenBank (Table 2). The newly generated sequences were deposited in GenBank.

Table 2. ITS rDNA sequences of the species used in the study and their GenBank accession numbers. The holotype of *L. sichuanensis* is indicated as [HT].

Species	Voucher	GenBank No.	Reference
*Lirula macrospo*ra		AF462440	NCBI
		AF462441	NCBI
Lirula yunnanensis		HQ902156	Fan et al. 2012
Lirula exigua		HQ902157	Fan et al. 2012
		HQ902154	Fan et al. 2012
		HQ902155	Fan et al. 2012
Lirula sichuanensis	SAUF1605001 [**HT**]	KY399845	This paper
	SAUF1606001	KY399846	This paper
*Lophodermium coni*genum		AY422489	Pan et al. 2006
*Lophodermium austr*ale		KM106810	Oono et al. 2014
		KM106812	Oono et al. 2014
*Lophodermium ind*ianum		KF636510	NCBI
		KF636502	NCBI
*Rhytisma panamens*e		GQ253102	Hou et al. 2010
*Rhizosphaera kalkhoff*ii		KM435342	Azeem et al. 2015
		JQ353721	You et al. 2013

Taxonomy

Lirula sichuanensis X.L. Xu, C.L. Yang & Y.G. Liu, **sp. nov.** Figs 1–12

MycoBank MB 819592

Differs from *Lirula macrospora* by its larger asci and ascospores, its branched, unswollen (or only slightly swollen) paraphyses, and its hypophyllous conidiomata forming a continuous or interrupted row on both sides of the substrate needle's stomatal line.

Type: China, Sichuan Province, Pingwu County, Yangdonghe Plantation, alt. 2822 m, on needle of *Picea likiangensis* var. *rubescens* Rehder & E.H. Wilson (*Pinaceae*), 5 May 2016, X.L. Xu & C.L. Yang 160504 (**Holotype**, SAUF1605001; GenBank KY399845).

Etymology: *sichuanensis*, referring to Sichuan Province where the specimens were collected.

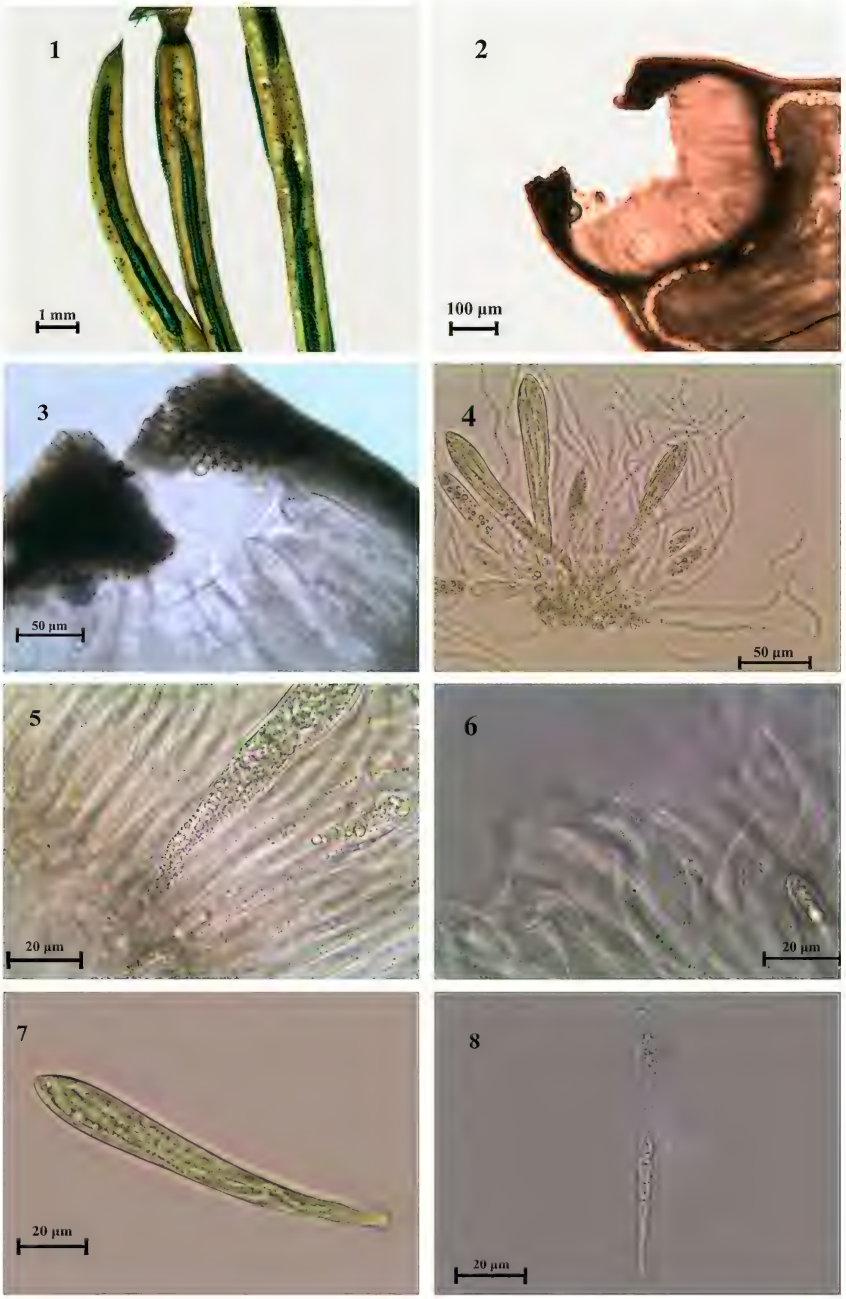
Ascomata hypophyllous (occasionally epiphyllous), nervisequious, on previous year dead needles but still attached to a living twig; dull to shining black in surface view, (2–)4–12(–17) × 0.38–0.6 mm, no perimeter line, variably long and extending at times almost the entire length of the needle; intra-epidermal in median vertical section, 190–330 μm deep; strongly raised above the surface of the substrate, opening widely by a single longitudinal split, exposing the canary yellow hymenium. Covering stroma conspicuous and well carbonized, no lip cell observed; ≤96–133 μm thick near the ascomal centre, becoming thinner towards the edges and not extending to the basal layer; consisting of an outer layer of host cuticle and epidermal cell remnants, an inner layer of brown to black brown textura angularis with 6–11 μm diam. cells, and an innermost layer of colourless to pale brown textura globulosa with 7–12 μm diam. cells. Hymenium concave to flat, (80–)100–210 μm thick. Subhymenium hyaline, deep concave, composed of hyaline, pseudoparenchymatous cells. Basal stroma poorly developed or almost absent. Paraphyses filiform, straight or curved, longer than asci, 180–240 μm long, 2.6–4.2 μm thick at the base, multi-septate, tapering towards the tip, 1.4–2.3 μm thick, not or only slightly swollen, often branched near the top or in the middle, surrounded by a gelatinous matrix 1.7–2.7 μm thick, but not forming an epithecium. Asci clavate, subtruncate at the apex when maturing, tapered below to a short stipe, 105–166 × 16–23 μm, J–, 8-spored. Ascospores cylindrical-clavate, hyaline, arranged in fascicles, 51–90 × 5–7 μm, rounded at the apex, tapered towards the base, encased in a conspicuous (3.7–6.6 μm thick) hyaline gelatinous sheath.

Conidiomata hypophyllous, on both sides of the stomatal lines, forming two continuous or interrupted rows on dead needles attached to living twigs, 110–360 μm wide, intra-epidermal in vertical section, 58–65 μm deep; concolorous with the substrate or pale brown, appearing as shining blisters, round or ellipse or irregular shape, opening by sparse little ostioles. Upper wall absent. Basal wall extremely poorly developed. Conidia hyaline, baculiform, straight or slightly curved, 4–7 × 2 μm.

Zone lines not observed.

Habitat & distribution: Producing conidiomata and ascomata on dead needles still attached to living twigs. Known only from Sichuan Province, China.

Figs. 1–8. *Lirula sichuanensis* (holotype, SAUF1605001) sexual stage on *Picea* needles. 1. Ascomata observed under the dissecting microscope. 2. Ascoma in vertical section. 3. Covering stroma near the centre of ascoma in vertical section. 4. Asci and paraphyses. 5. Paraphysis bases and a young ascus. 6. Paraphysis tips. 7. Ascus containing eight ascospores. 8. A single released ascospore.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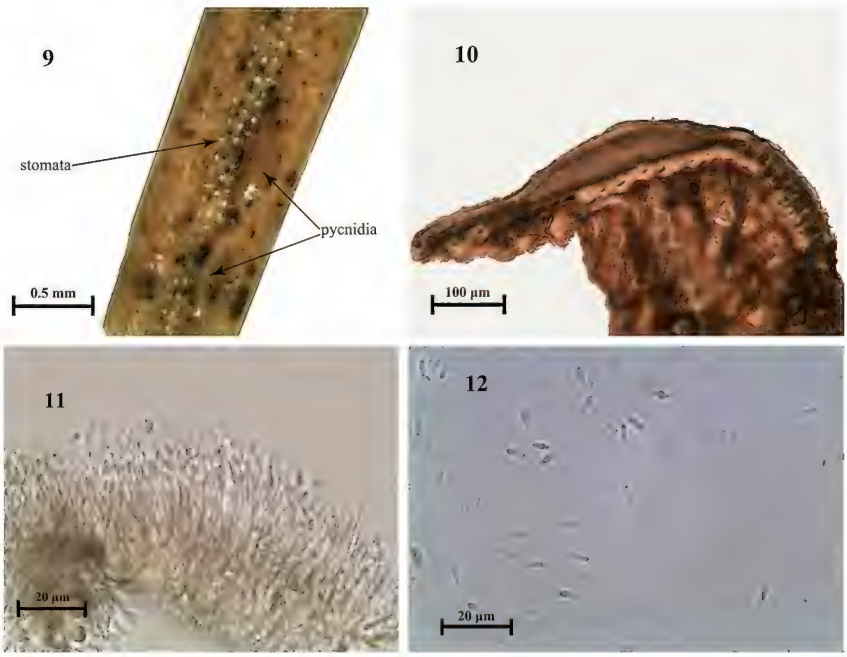

Figs. 9–12. *Lirula sichuanensis* (SAUF1606001) asexual stage on *Picea* needles. 9. Pycnidia observed under the dissecting microscope. 10. Pycnidium in vertical section. 11. Sporogenous tissue. 12. Conidia.

Additional specimens examined—**CHINA, Sichuan Province, Pingwu County,** Yangdonghe Plantation, alt. 2822 m, on *Picea likiangensis* var. *rubescens*, 13 June 2016, X.L. Xu & C.L. Yang 160613 (SAUF1606001; GenBank KY399846); **Ganzi Autonomous Prefecture, Luhuo County**, alt. 3240 m, on *Picea likiangensis* var. *rubescens*, 30 July 2014, X.L. Xu & C.L. Yang 140730 (SAUF1407001).

Discussion

Few gene sequences of *Lirula* are available in GenBank. ITS rDNA sequence analysis clustered *L. sichuanensis* in an independent lineage with *L. macrospora* and *L. yunnanensis* on a branch with 70% bootstrap support apart from *L. exigua* in a distant clade. *Lirula exigua* differs from *L. sichuanensis*, *L. macrospora*, and *L. yunnanensis* (Darker 1932, Fan et al. 2012) in its paraphyses not swollen at tips, narrower asci, shorter ascospores, and conidiomata that are scattered and not in continuous rows. Additionally, *L. exigua* has been observed in needles on dead twigs; the areas of needles with ascomata are whitened and fragile; and the ascomal color and shape are somewhat different (Fan et al. 2012).

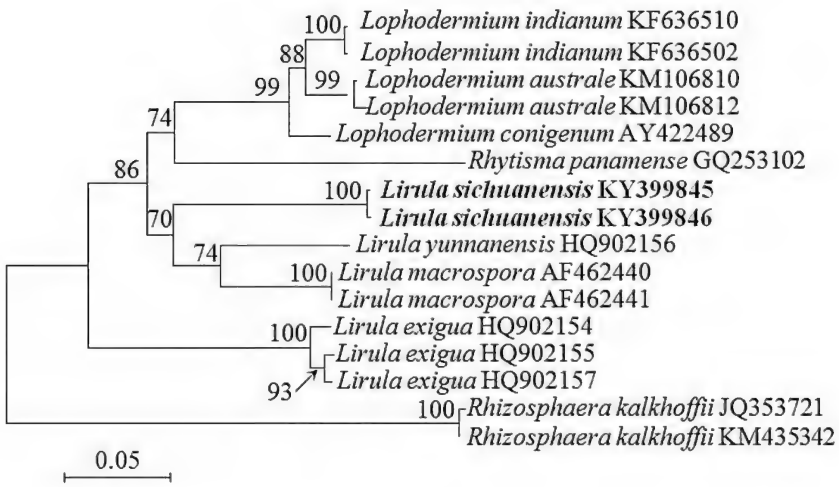

FIG. 13. Neighbor-joining phylogeny generated from partial ITS sequence analysis of *Lirula sichuanensis* and related species, using *Rhizosphaera kalkhoffii* as outgroup. Bootstrap values >80% from 1000 replications are shown on the respective branches.

Consequently, *L. exigua* needs further taxonomic study (including comparison with the type species, *L. nervisequa*) to establish whether it belongs in *Lirula*.

Lirula sichuanensis differs from other species in its distinctive paraphyses, which are longer and thicker, multi-septate, usually curved, and not to only slightly swollen at the tips (often branched near the middle or the apex) and thicker gelatinous sheath. In addition, the ascospores and gelatinous sheath are thicker, and the conidia are broader. The new species shares a similar habit with *L. brevispora* and *L. macrospora* on the needles of *Picea* spp. (Darker 1932, Ziller 1969) but differs from them by its longer thicker branched paraphyses, conspicuously larger or wider ascospores and gelatinous sheath, and inconspicuous basal stroma. *Lirula macrospora* differs in its smaller (100–132 × 14–16 μm) clavate-cylindric asci, much smaller (56–68 × 2.5–3 μm) clavate ascospores, unbranched paraphyses with swollen tips, irregularly scattered or sometimes 2–3 coalescent conidiomata that do not form two continuous or interrupted rows on needles (Darker 1932), much smaller (2.5–4.5 × 1.2–1.5 μm) conidia, and sometimes producing trichogynes (Lin et al. 2012). Ascal shape and size of *L. sichuanensis* is similar to that of *L. yunnanensis*, which differs by its bluish grey to bluish black ascomata, its narrower ascospores often

covered by gelatinous caps and a thinner gelatinous sheath, and its bigger, deeper, pale yellowish brown, epiphyllous, nervisequious pycnidia (Fan et al. 2012).

Lirula sichuanensis causes serious needle blight of *Picea likiangensis* var. *rubescens* in planted forests in Sichuan. It usually infects 1-year-old needles of 20- to 30-year-old trees from May to July and in the following March to May produces ascomata on 2-year-old needles. According to our survey, this disease spreads quickly in planted spruce forests. An overall investigation is needed to understand the scope and area affected by the disease, and this pathogen should be controlled at ecological security level by forestry measures or drug treatment.

Acknowledgments

The authors are grateful to Prof. Y.R. Lin and Dr. H.D. Zheng for serving as pre-submission reviewers leading to the improvement of our manuscript and to Dr. Shaun Pennycook for critical review of the manuscript and nomenclature help. This study was supported by the Forest Pest Management and Quarantine Station of Sichuan Province for the Ecological Forest Diseases and Pests Control along the Upper Yangtze River.

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MYCOTAXON

ISSN (print) 0093-4666 (online) 2154-8889 Mycotaxon, Ltd. ©2017

October–December 2017—Volume 132, pp. 849–855

https://doi.org/10.5248/132.849

Hypoderma rubi on two new hosts in Slovakia

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Abstract—*Hypoderma rubi* was found on the previous year's fallen petioles of *Fraxinus chinensis* subsp. *rhynchophylla* and on attached dead twigs of *Rhododendron fortunei* in Slovakia. The fungus, which is recorded for the first time on these host taxa, also represents a new taxon for the Slovak mycota. The morphological characteristics of the fungus found on Slovak collections are described.

Key words—Chinese ash, Fortune's rhododendron, morphology, *Rhytismataceae, Rhytismatales*

Introduction

Hypoderma rubi, the type and best-known species of *Hypoderma* (*Rhytismataceae*, *Rhytismatales*), occurs on a large number of herbaceous and woody plant genera and has an extensive geographical distribution. According to Farr & Rossman (2017), most records are from Asia (China, India), although the fungus has also been recorded in New Zealand, North America (USA), Central America (Panama), and Europe (Czech Republic, Germany, Spain, Sweden, Ukraine, United Kingdom). European findings of the fungus are mainly on the type host genus *Rubus* L. (Hilitzer 1929, Lotz-Winter et al. 2011, Moreno et al. 2004, Eriksson 2014, Lantz et al. 2011, Dudka et al. 2004, Cannon et al. 1985). There are also some specimens of *H. rubi* from other European countries (Channel Islands, Italy, Norway), Asia (Japan), South America (Chile), and Africa (Malawi) in the K & IMI

fungaria (Royal Botanic Gardens, Kew) that have not yet been formally published.

In 2015, during a survey of the mycota of trees and shrubs in Mlyňany Arboretum of the Slovak Academy of Sciences, two collections of *H. rubi* were made. This species is not listed in the checklist of fungi of Slovakia (Lizoň & Bacigálová 1998), and there are no previous records of it in Slovakia. Petrak's records of *H. rubi* on *Rubus* spp. (deposited in international herbaria, e.g. BPI, IMI, K) collected in the former Czechoslovakia, originate in the territory of Czech Republic. This paper presents, therefore, the first collections of *H. rubi* from Slovakia, and the first on *Fraxinus chinensis* subsp. *rhynchophylla* (Hance) A.E. Murray and *Rhododendron fortunei* Lindl. A description and illustrations of the fungus based on the Slovak collections are provided.

Materials & methods

The previous year's petioles of *F. chinensis* subsp. *rhynchophylla* and attached dead twigs of *R. fortunei* were collected in the Mlyňany Arboretum (south-west of Slovakia) in autumn 2015. The specimens were examined using an Olympus SZ61 stereomicroscope and Olympus BX51 standard light microscope. Morphological and microscopic examinations were carried out on dried material rehydrated in water. Lactophenol blue solution (Merck, Darmstadt) was used to stain hyaline structures. The morphological structures of the fungus were photographed using an Olympus SP350 digital camera. We compared our measurements with previously published descriptions. Voucher specimens are deposited in the Plant Pathology Herbarium of the Institute of Forest Ecology of Slovak Academy of Sciences, Nitra, Slovakia (NR).

Taxonomy

Hypoderma rubi (Pers.) DC. ex Chevall.,
J. Phys. Chim. Hist. Nat. Arts. 94: 31 (1822) FIGURE 1

= *Hypoderma virgultorum* DC., Fl. Franç., Ed. 3, 6: 165 (1815), nom. illeg.
= *Hypoderma commune* (Fr.) Duby, Mém. Soc. Phys. Hist. Nat. Genève 16: 53 (1861)

HYSTEROTHECIA embedded in the previous year's fallen Chinese ash petioles and in paler portions of Fortune's rhododendron twigs, abundant, subcuticular, black, elliptical to elongated-elliptical, raising the substrate surface, (0.4–)0.8–2.7 × 0.3–0.6 mm, opening by a single longitudinal split, lips grey, clypeus thickened towards the lips. LIP CELLS hyaline, 14–20.5 × 2.5–3.5 µm. ASCI unitunicate, clavate, long-stalked, (75–)90–125 × 10–14.5 µm, 8-spored. ASCOSPORES hyaline, aseptate, guttulate, elongated-

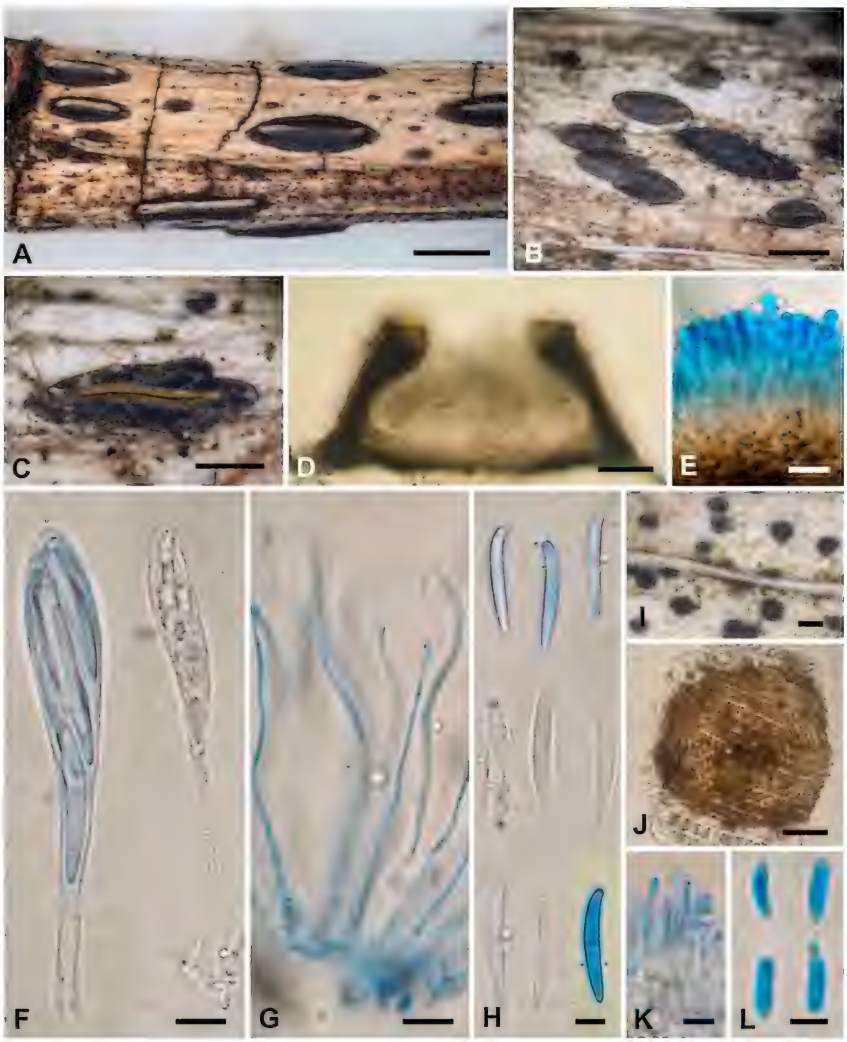

Figure 1. *Hypoderma rubi* (A, C–H = NR 5477; B, I–L = NR 5478). A: Hysterothecia, pycnidia and zone lines on *Fraxinus* petiole; B: Hysterothecia on *Rhododendron* twig; C: Mature hysterothecium (surface view); D: Hysterothecium in vertical section; E: Lip cells; F: Asci with ascospores; G: Paraphyses; H: Ascospores; I: Pycnidia (surface view); J: Pycnidium (detail of surface appearance); K: Conidiogenous cells with conidia; L: Conidia. Scale bars: A, B = 1 mm; C = 0.5 mm; D = 100 µm; E, H, K = 5 µm; F, G = 10 µm; I = 200 µm; J = 50 µm; L = 2 µm.

clavate to cylindrical, bent towards the top end, 18–25 × 2.5–3.5 µm, usually not covered by a gelatinous sheath but sometimes clad in a thin sheath.

Table 1. Biometric characteristics of *Hypoderma rubi* from the Slovak material and as reported by other authors.

Morphology	Cannon & Minter (1986)	Johnston (1990)	Slovak material
Hysterothecia (mm)	1.4–2.5(–3.0) × 0.5–0.75	0.8–3.0 × 0.3–0.6	(0.4–)0.8–2.7 × 0.3–0.6
Asci (µm)	87–130 × 12–14.5	110–160 × 11–14	(75–)90–125 × 10–14.5
Ascospores (µm)	(16–)20–24(–30) × 2.5–3.5	15–28 × 2.5–5.5	18–25 × 2.5–3.5
Pycnidia (µm diam.)	75–250(–300)	100–300	(80–)105–220
Conidia (µm)	2–4 × 0.75–1	3–5 × 1–1.5	2–4 × 1

Paraphyses hyaline, filiform, septate, branched or unbranched, not swollen at the apex, as long as mature asci, covered by a gelatinous sheath. Pycnidia subcuticular, black, circular, (80–)105–220 µm diam., opening by 1–2 small central ostioles, accompanying the hysterothecia. Conidiogenous cells cylindrical, tapering towards the apex, hyaline, 7–12 × 1–2 µm. Conidia cylindrical, sometimes allantoid, hyaline, aseptate, 2–4 × 1 µm. Zone lines black, thin.

Specimens examined—**SLOVAKIA. Vieska nad Žitavou, Mlyňany Arboretum,** 48.3203°N 18.3668°E, on the previous year's petioles of *Fraxinus chinensis* subsp. *rhynchophylla* (*Oleaceae*), 2 Oct. 2015, leg. et det. K. Pastirčáková (NR 5477); 48.3208°N 18.3692°E, on dead attached twigs of *Rhododendron fortunei* (*Ericaceae*), 9 Nov. 2015, leg. et det. M. Pastirčák (NR 5478).

The fungus was identified as *Hypoderma rubi* based on morphological description and measurements of reproductive structures. A comparison of some biometric characteristics of *H. rubi* on *Rubus* sp. (Cannon & Minter 1986), on different host plants (Johnston 1990), and of the Slovak material is given in Table 1. Morphometric data of the Slovak collections correspond well to previously published descriptions. Although ascospores usually are not covered by a gelatinous sheath, a thin sheath was often observed after staining (Fig. 1H). Hou et al. (2007) also recorded *H. rubi* on *Cunninghamia lanceolata* (Lamb.) Hook. (*Cupressaceae*) with ascospores clad in a thin gelatinous sheath.

The findings of *H. rubi* on *F. chinensis* subsp. *rhynchophylla* and *R. fortunei* from Slovakia represent the first records of the fungus in the country and new host taxa for the fungus.

Discussion

Rubus is the principal host genus on which *Hypoderma rubi* is most commonly collected (Minter 1984). However, according to Farr & Rossman

(2017), *H. rubi* has been recorded on leaves, stems, and petioles of species representing 35 host genera in 27 families. The species therefore seems to be widely plurivorous, although Cannon & Minter (1986), who doubt the conspecificity of the fungi on these hosts, suggest that numerous taxa may be involved. According to Lantieri et al. (2011), the genetic relationships amongst specimens identified as *H. rubi* are poorly resolved and the application of this name by different authors is uncertain. There are as yet very few molecular data available for *H. rubi* and from only a few hosts (Lantieri et al. 2011, Lantz et al. 2011). A comprehensive phylogenetic study is necessary to determine their identity and relationships.

Hypoderma rubi on *Rhododendron* sp. has been recorded in Europe (Wales; Smith 1951) and Asia (Malaysia; Spooner 1991). In China, four other *Hypoderma* species are known on *Rhododendron* spp.: *H. rhododendri-mariesii* Y.R. Lin & S.J. Wang on *R. mariesii* Hemsl. & E.H. Wilson (Lin et al. 2004), *H. cuspidatum* C.L. Hou & M. Piepenbr., *H. shiqii* C.L. Hou & M. Piepenbr., and *H. urniforme* C.L. Hou & M. Piepenbr. on *Rhododendron* sp. (Hou & Piepenbring 2006, Hou et al. 2007). They differ from *H. rubi* mainly by the shape and position of their hysterothecia as well as ascospore characteristics. *Hypoderma rhododendri-mariesii* has smaller (<860 µm long) hysterothecia, asci with cylindric-fusiform ascospores, and shorter ((9–)11–17 µm) ascospores; *H. cuspidatum* has intraepidermal hysterothecia with acute ends, ascospores with thick gelatinous sheaths, and unbranched paraphyses; *H. shiqii* has intraepidermal hysterothecia without lips that often open with one slit and additional lateral fissures, clavate asci with bifusiform ascospores, and ascospores with thick gelatinous sheaths; and *H. urniforme* is characterised by urniform, intraepidermal hysterothecia with red-brown lips and almost cylindrical asci with ellipsoidal to long-ellipsoidal ascospores with irregular gelatinous sheaths. *H. cuspidatum, H. shiqii,* and *H. urniforme* often occur together on the same twigs (Hou et al. 2007).

On-line databases of the British Mycological Society (Fungal Records Database of Britain and Ireland, http://www.fieldmycology.net) and Royal Botanic Gardens, Kew (Herb. IMI database, http://www.herbimi.info) include data on fungarium specimens of *H. rubi* on dead fallen leaves and dead attached twigs of *Rhododendron ponticum* L., *R. sinogrande* Balf. f. & W.W. Sm. and *R.* sp. from Scotland (IMI 358124b, 358144, 358155, 358157, 358158a); and on dead fallen petioles of *Fraxinus excelsior* L. from England (IMI 339025, K(M)160355). These records are evidently not yet published.

In the USA, Hanlin (1963) recorded *Hypoderma commune* on *Fraxinus americana* L.; however Powell (1974) treated *H. commune* as a synonym of *H. rubi*. Based on the available literature and electronic resources, we consider that only one *Hypoderma* species, *H. rubi,* has been recorded on *Fraxinus*.

Acknowledgments

We sincerely thank Roger T.A. Cook (UK) and Brian M. Spooner (UK) for kindly correcting the English and for their valuable comments, which helped to improve the manuscript. The authors are also indebted to Peter R. Johnston (Landcare Research, Auckland, New Zealand) and Hyeon-Dong Shin (Korea University, Seoul, South Korea) for critical comments on the manuscript and for acting as peer-reviewers. This study was supported by the Scientific Grant Agency of the Ministry of Education of the Slovak Republic and of Slovak Academy of Sciences, projects VEGA No. 2/0071/14 and No. 2/0183/14.

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MYCOTAXON

ISSN (print) 0093-4666 (online) 2154-8889 Mycotaxon, Ltd. ©2017

October–December 2017—Volume 132, pp. 857–865

https://doi.org/10.5248/132.857

New reports of *Myriospora* (*Acarosporaceae*) from Europe

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Abstract—*Myriospora dilatata* is newly reported for the Czech Republic and *M. myochroa* new for Italy. *Myriospora rufescens* was rediscovered in Germany almost 100 years after its first collection. A neotype is designated for *Acarospora fusca,* which is recognized as a synonym of *M. rufescens.*

Key words—*Myriospora hassei*, *Silobia*, *Trimmatothelopsis*

Introduction

The genus *Myriospora* in the *Acarosporaceae* is a well-supported clade distinguished by a constellation of morphological characters (non-lecideine apothecia, high hymenium, thin paraphyses, interrupted algal layer, short conidia, no secondary metabolites or norstictic acid) (Wedin et al. 2009; Westberg et al. 2011, 2015). The genus currently contains 12 species that occur in Antarctica, Asia, Europe, and North and South America (Knudsen 2011, Westberg et al. 2011, Knudsen et al. 2012, Knudsen & Bungartz 2014, Schiefelbein et al. 2015, Purvis et al. in press). *Myriospora fulvoviridula* (Harm.) Cl. Roux is a synonym of *M. scabrida* (H. Magn.) K. Knudsen & Arcadia (Knudsen et al. 2017, Roux et al. 2014). The most common species in the genus is *M. smaragdula* (Wahlenb.) Nägeli ex Uloth, which occurs in Asia, Europe, North and South America (Magnusson 1929, Knudsen 2007, Westberg et al. 2011, Knudsen et al. 2012). The center of diversity of the genus appears to be in Europe where nine species occur. The genus was originally treated as *Silobia*

(Westberg et al. 2011, Knudsen 2011) and briefly as *Trimmatothelopsis* [(Roux & Navarro-Rosinés 2011); for a current circumscription of *Trimmatothelopsis* see Knudsen & Lendemer 2016]. It is now treated under its oldest available name *Myriospora* (Arcadia & Knudsen 2012).

While the reported diversity of *Acarosporaceae* is high in Europe (Magnusson 1929, 1956), no species is particularly frequent except for *Acarospora fuscata* (Schrad.) Arnold. It is not unusual to collect all day on rocks and soil in the Czech Republic, Germany, or the Italian Alps and only find one or two species of *Acarosporaceae* besides *A. fuscata*. Because of this diversity of taxa and infrequency of populations, not to mention problems identifying many species, there are possibilities for new discoveries. In this paper, we report three new records of *Myriospora* species in Europe.

Materials & methods

Myriospora specimens from institutional herbaria (PRM, STU, TBS, UCR, UPS) and personal herbaria of Jana Kocourková and Kerry Knudsen (hb. K & K) and Ulf Schiefelbein (hb. Schiefelbein) were determined using key and descriptions by Westberg et al. (2011). They were analyzed with standard microscopy and spot tests (Nash et al. 2002). Undiluted fresh Lugol's solution (Merck) was used to test amyloid reactions of the hymenium and subhymenium. The description of *M. rufescens* according to Westberg et al. (2011) was revised. Jana Kocourková photographed *M. rufescens* using a digital camera Olympus DP72 attached to an Olympus SZX7 Stereomicroscope and Olympus BX51 fitted with a Nomarski differential interference contrast and image stacks processed with software Olympus Deep Focus 3.1.

Taxonomy

Myriospora dilatata (M. Westb. & Wedin) K. Knudsen & Arcadia, Opusc. Philolich. 11: 21, 2012.

≡ *Silobia dilatata* M. Westb. & Wedin, Lichenologist 43(1): 12, 2011.

Type: Sweden. Torne Lappmark. Jukkasjärvi par., Tornehamn, shore of Lake Torneträsk, on silicate rock, 3 Sept. 2006, E. Baloch SW116 (S [n.v.], holotype).

≡*Trimmatothelopsis dilatata* (M. Westb. & Wedin) Cl. Roux & Nav.–Ros., Bull. Soc. Linn. Provence 62: 176, 2011.

Description. See Westberg et al. (2011, as *Silobia dilatata*). For pictures see Westberg et al. (2011) and Wirth et al. (2013).

Ecology & distribution. Ferrophilous, heavy metal tolerant, often in moist habitats near streams. Czech Republic (Bohemia), Germany (Wirth et al. 2011, 2013), Norway (Westberg et al. 2011), Sweden (Westberg et al. 2011).

Specimen examined. **CZECH REPUBLIC. Northern Bohemia.** Krkonoše Mts, Sněžka Mt., SSE of former mine 'Kovárna', 50°43′35″N 15°43′58.7″E, alt. 1075 m, humid

lower edge of boulder scree, mica-schist outcrop enriched of heavy metals (copper ores and arsenopyrite), 8 Sept. 2016, J. Kocourková 9083 & K. Knudsen (hb. K & K).

Discussion. *Myriospora dilatata* is easily identified among *Myriospora* by its orange to reddish areoles, non-punctiform apothecia, lack of secondary metabolites, and occurrence on substrates rich in iron and other heavy metals (Westberg et al. 2011). The species is reported as rare in Bohemia in the Czech Republic. In the Krkonoše Mountains *M. dilatata* was growing on a mica-schist outcrop enriched with heavy metals (copper ores and arsenopyrite) in a relatively moist habitat with abandoned mining pits. In these same mountains, the often red-powdered ferrophilous species *Acarospora sinopica* (Wahlenb.) Körb. is common (hb. K & K) and there have been several collections by Zdeněk Palice (PRA) and V. Kuťák (PRM) of the orange ferrophilous species *M. tangerina* (M. Westb. & Wedin) K. Knudsen & Arcadia (Westberg et al. 2011, Knudsen et al. 2017). Punctiform apothecia easily distinguish *A. sinopica* from *M. dilatata* with its areoles with dilated apothecia. With difficult specimens the full description and discussion of *A. sinopica* in Magnusson (1929) is informative. Punctiform apothecia also distinguish *M. tangerina* from *M. dilatata* as well as large squamules. An apparently cryptic ferrophilous taxon of *Myriospora*, similar in appearance to *M. dilatata* and sometimes identified as *Acarospora smaragdula* f. *subochracea* H. Magn., was reported in an unpublished molecular analysis of specimens from the Alps but not yet described (Westberg et al. 2011). This report extends the range of *M. dilatata* from Fennoscandia to Central Europe.

Myriospora myochroa (M. Westb.) K. Knudsen & Arcadia, Opusc. Philolich. 11: 22, 2012.

≡ *Silobia myochroa* M. Westb., Lichenologist 43(1): 14, 2011.

Type: Sweden. Bohuslän. Orust, Morlanda Parish, near car park at Stocken, grid ref: (RT90) 6456258 1241653, c. 1 m, on the vertical surface of a SW-facing rock, 16 Sept. 2003, A. Crewe & O. W. Purvis 719 (S [n.v.], holotype).

≡ *Trimmatothelopsis myochroa* (M. Westb.) Cl. Roux & Nav.-Ros., Bull. Soc. Linn. Provence 62: 176, 2011.

Description. For description and pictures Westberg et al. (2011, as *Silobia myochroa)*. For picture and map of Italian distribution, see Nimis & Martellos (2017).

Ecology & distribution. Asia, Europe. Often on silicate rock underhangs at low to high elevations. In salt spray zone along Atlantic coast. Czech Republic (Malíček & Vondrák 2016), Finland (Westberg et al. 2011), France (Roux et al. 2014), Germany (Wirth et al. 2013, Schiefelbein et al. 2015), Italy, Norway

(Westberg et al. 2011), Poland (Flakus 2014), Russia (Siberia) (Zhdanov 2013), Sweden (Westberg et al. 2011).

Selected specimen examined. **ITALY. Friuli. Giogaia dei Fleors**: sen tiero vs la cima, 2406 m, in silicate rock underhang, 17 Aug. 1996, M. Tretiach 24565 (TBS).

Discussion. Our discovery of specimens of *Myriospora myochroa* in TBS extends the species range into Italy. If spot tests are negative and crystals of norstictic acid are not observed in the cortex with polarized light, *M. myochroa* is sometimes misidentified as *M. hassei* (Herre) K. Knudsen & Arcadia, a species we currently consider endemic to the Pacific Plate Lichen Bioregion on the south and central coast of California (Knudsen 2011, Knudsen & Bungartz 2014, Nimis 2016, Nimis & Martellos 2017).

Myriospora rufescens (Ach.) Hepp ex Uloth, Flora 44: 618, 1861. Fig. 1

≡ *Sagedia rufescens* Ach., Lichenogr. Univ. 329, 1810.

Type: Great Britain. England. Turner 23 (H-ACH-980[n.v.]), lectotype (designated in Westberg et al. 2011).

≡ *Lecanora rufescens* (Ach.) Nyl., Flora 55: 364, 1872.

≡ *Acarospora rufescens* (Ach.) Kremp., Lich.-Fl. Bayern.: 173 (1861).

≡ *Silobia rufescens* (Ach.) M. Westb. & Wedin, Lichenologist 43(1): 18, 2011.

≡ *Trimmatothelopsis rufescens* (Ach.) Cl. Roux & Nav.-Ros., Bull. Soc. Linn. Provence 62: 176, 2011.

= *Acarospora fusca* B. de Lesd., Recherch. Lich. Dunkerque 1(Suppl.): 100, 1914, syn. nov.

Type: France. Dunkerque. Malo Terminus, dunes, 1910, B. des Lesdain s.n. (holotype [n.v.]. Presumed lost in bombing of Dunkirk in WW2). Germany. Mecklenburg. West Pomerania, Vorpommern-Greifswald, Greifswald, Koos Island, eastern edge of the island, 54°10′13″N 13°25′19″E, c. 1 m, on single boulder on boulder beach, 6 Aug. 2004, U. Schiefelbein 4446 (**Neotype designated here**, NY; **isoneotype**, hb. Schiefelbein).

Hypothallus endosubstratic, I–. Thallus epilithic, areolate, areoles verruciform [areoles with an immersed apothecium dilating until the thallus is reduced to a thalline margin around the disc and often resembling *Lecanora* apothecia and/or areoles not verruciform, rounded to angular, 0.4–0.9(–1.5) mm diam., on smooth surfaces forming a contiguous indeterminate crust, becoming dispersed on uneven rock surface, replicating by the division of the areoles, the upper surface dark grey to dark greyish or reddish brown, epruinose, smooth to rugulose, flat to somewhat convex, lower surface broadly attached, epicortical layer lacking, upper cortex (10–)40–60 µm thick, paraplectenchymatous but individual cells difficult to distinguish, ≤5 µm diam. Algal layer with or without distinct interruption by thin hyphal bundles, ca. 100 µm tall, continuous beneath apothecia. Medulla continuous with attaching

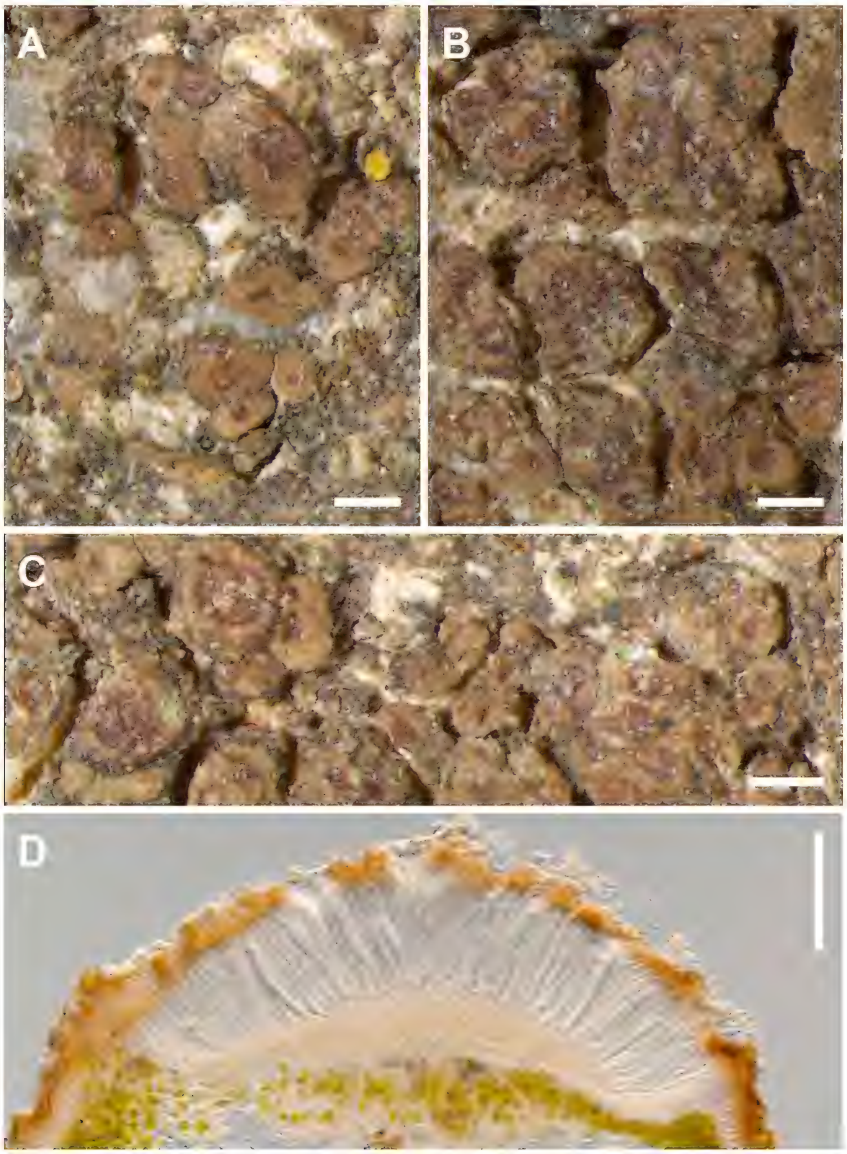

Fig. 1. *Myriospora rufescens* (*Acarospora fusca* neotype, Schiefelbein 4446): A. Dispersed areoles of the thallus with solitary apothecia; B. Areoles with mostly solitary apothecia forming a contiguous indeterminate crust; C. Apothecia 1–(2–4) per areole in contiguous crust; D. Vertical section of ascoma. Scale bars: A–C = 500 µm; D = 100 µm.

hyphae, mostly 2–3 µm wide, mixed with substrate particles. Apothecia 1–(2–4) per areole, immersed, disc rounded, 0.07–0.25(–0.60) mm diam., reddish brown to blackening, flat, smooth or rough, epruinose, parathecium colorless in section, ca. 15 µm below the hymenium, expanding up to 60 µm near the surface, uppermost cells with dark brown caps, forming an indistinct perithecial crown concolorous with the thallus or becoming blacker, epihymenium reddish brown to dark brown. Hymenium (100–)120–140(–160) µm tall (as low as 85 µm per Magnusson 1929), I– red. Paraphyses 1–1.5 µm wide at midlevel, sparsely branched, tips cylindrical to clavate, widened to 2.5 µm, asci up to 150 × 27 µm. Ascospores narrowly ellipsoid to bacilliform, 3–6 × (1–)1.5(–2) µm. Subhymenium opaque, (20–)40–55 µm tall inspersed with oil drops, I+ blue. Pycnidia not observed.

Ecology & distribution. Usually on smooth or rough surfaces of silicate rock. Czech Republic (Magnusson 1929), France (Roux et al. 2014), Germany (Magnusson 1929, Westberg et al. 2011), Norway (Westberg et al. 2011), Sweden (Westberg et al. 2011), United Kingdom (Magnusson 1929, Fletcher et al. 2009, Westberg et al. 2011).

Other specimens examined. **GERMANY. Lower Saxony. District Stade**, Neßsand island: c. 250 m W of the Inselwarthaus, 53°33′20″N 9°45′25″E, c. 5 m, acidophilous, nutrient-poor grassland with single shrubs, on siliceous stone in the grass, 26 Sept. 2015, U. Schiefelbein 4415, (hb. Schiefelbein); c. 200 m S of the Inselwarthaus, 53°33′15″N 9°45′40″E, c. 5 m, pile of stone in a nutrient-poor grassland, forming large patch on siliceous boulder, 26 Sept. 2015, U. Schiefelbein 4416 (hb. Schiefelbein).

Discussion. *Myriospora rufescens* is distinguished from other members of the genus by its small (≤0.5 mm diam.) apothecia with a relatively short (usually 120–140 µm) hymenium with thin paraphyses and tall subhymenium inspersed with oil drops (Westberg et al. 2011). As in *M. dilatata*, the apothecia are not punctiform but dilated, often forming verruciform areoles reminiscent of *Lecanora* apothecia.

Magnusson (1929) considered *Acarospora rufescens* and *A. fusca* to represent distinct species, but we consider them conspecific, representing two different morphotypes that can intergrade even in the same population. Thus in Magnusson (1929), *A. rufescens* was the morphotype with verruciform areoles often resembling *Lecanora* apothecia (see Fig. 1a and also lectotype photo in Westberg et al. 2011) while *A. fusca* represented the morphotype with mostly contiguous non-verruciform areoles, often with two or more apothecia and usually forming a thin indeterminate crust (Fig. 1b,c). The holotype of *A. fusca* in Bouly de Lesdain's herbarium is presumed to have been lost in World War II during the 1940 bombing of Dunkirk, as were many other specimens cited by

Fig. 2. *Acarospora fusca* neotype locality on boulder beach in Koos Island, Mecklenburg, Germany.

Magnusson in his *Acarospora* monograph (Magnusson 1929, Abbeyes 1966). The only recorded collection of *M. rufescens* in Germany was made in Anhalt, Bernburg, by G.H. Zschacke in 1907 (Magnusson 1929, Westberg et al. 2011, Wirth et al. 2013). This German collection of *M. rufescens* was identified as *A. fusca* (Magnusson 1929). We designate a modern collection by Ulf Schiefelbein from Koos Island in Germany as the neotype of *A. fusca*, deposit it in NY, and formally recognize *A. fusca* as a synonym of *M. rufescens*. It has been over 100 years since *M. rufescens* was last collected in Germany in 1907. A return trip to Koos Island revealed no additional *M. rufescens* on the other rocks along the shore.

Myriospora rufescens is a small species that can be overlooked, especially in a mixed saxicolous community. The three 21st century German collections suggest that *M. rufescens* prefers microhabitats with high annual relative humidity. The neotype locality for *Acarospora fusca* on Koos Island is a boulder beach on the western edge of Greifswalder Bodden, a bay of the Baltic Sea (Fig. 2). The neotype population occurred on the top of a large boulder that was not usually inundated but regularly sprayed by waves of brackish water, leaving salt crystals embedded in the cortex and apothecia. The two other modern German sites for *M. rufescens* were on the small narrow island of Neßsand, located just downstream from Hamburg at the mouth of Elbe River.

Acknowledgments

We thank our reviewers, J.C. Lendemer (NY) and J. McCarthy, S.J. (Canada). We thank for their assistance P.L. Nimis (TBS) and the curators of PRA, PRM, STU, TBS, UCR, and UPS. The work of Jana Kocourková and Kerry Knudsen was financially supported by 42900/1312/3166 [Environmental aspects of sustainable development of society], a grant from the Faculty of Environmental Sciences, Czech University of Life Sciences Prague.

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MYCOTAXON

ISSN (print) 0093-4666 (online) 2154-8889 Mycotaxon, Ltd. ©2017

October–December 2017—Volume 132, pp. 867–874

https://doi.org/10.5248/132.867

Perenniporia puerensis sp. nov. from southern China

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Abstract—A new polypore, *Perenniporia puerensis*, collected from Yunnan province, southern China, is described and illustrated based on four collections using morphology-based methods. Macroscopically, the new species is characterized by an annual growth habit, resupinate basidiocarps with a yellow to ochraceous pore surface, and 4–6 pores per mm. Microscopically, it has a dimitic hyphal system with non-dextrinoid and cyanophilous skeletal hyphae that are encrusted with pale-yellow crystals, and basidiospores that are ovoid to subglobose, thick-walled, non-dextrinoid, cyanophilous, and 4.3–5.5 × 3.7–4.7 µm.

Key words— *Basidiomycota*, *Polyporaceae*, *Polyporales*, taxonomy, white rot fungus

Introduction

Perenniporia Murrill is a large, cosmopolitan genus characterized by poroid basidiomata and basidiospores that are thick-walled, ellipsoid to distinctly truncate, cyanophilous and variably dextrinoid and amyloid. The hyphal system in *Perenniporia* is di- or trimitic with clamp connections on the generative hyphae and vegetative hyphae that are cyanophilous and variably dextrinoid or amyloid (Decock & Stalpers 2006). Approximately one hundred species have been described in or transferred to the genus (Gilbertson & Ryvarden 1987; Decock & Ryvarden 1999; Hattori & Lee 1999; Decock et al. 2001; Núñez & Ryvarden 2001; Choeyklin et al. 2009; Cui & Zhao 2012; Zhao & Cui 2013a,b; Zhao et al. 2013; Ryvarden & Melo 2014; Jang et al. 2015; Decock 2016).

Phylogenetic studies of *Perenniporia* s.l. inferred from nuclear ribosomal LSU and ITS DNA sequence data well support several monophyletic groups that can be recognized as distinct genera (Robledo et al. 2009; Zhao & Cui 2013a,b; Zhao et al. 2013) within the polyporoid clade.

Fifty *Perenniporia* species have been recorded during recent taxonomic surveys in China (Dai et al. 2002, 2015; Dai 2012), including several new species (Cui et al. 2007; Xiong et al. 2008; Dai 2010; Dai et al. 2011; Cui & Zhao 2012; Zhao & Cui 2012, 2013a,b; Zhao et al. 2013, 2014). During one such recent survey, we identified an undescribed species matching the concept of *Perenniporia*.

Materials & methods

Cited specimens are deposited at the herbarium of Southwest Forestry University, Kunming, China (SWFC). Microscopical protocols follow Dai (2012). Sections were examined at magnifications up to 1000× using a Nikon Eclipse E 80i microscope and phase contrast illumination. Drawings were made with the aid of a drawing tube. Microscopic features, measurements, and drawings were made from slide preparations stained with Cotton Blue and Melzer's reagent. Spores were measured from sections cut from the tubes. To present spore size variations, 5% of measurements were excluded from each end of the range, and extreme values are given in parentheses. In the text the following abbreviations are used: M = Melzer's reagent, M– = both inamyloid and nondextrinoid, KOH = 5% potassium hydroxide, CB = Cotton Blue, CB+ = cyanophilous, L = mean spore length (arithmetic average of all spores), W = mean spore width (arithmetic average of all spores), Q = the range of variation in the L/W ratios of n number of basidiospores, n = number of basidiospores measured from the 4 specimens studied. Special color terms follow Petersen (1996).

Taxonomy

Perenniporia puerensis C.L. Zhao, **sp. nov.** Figs 1, 2

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Differs from *Perenniporia straminea* by its bigger pores and bigger basidiospores, from *P. tibetica* by its smaller pores and the absence of rhizomorphs; and from *P. subacida* by its annual growth habit, its non-dextrinoid skeletal hyphae, and its truncate basidiospores.

Type: China. Yunnan Province: Puer, Laiyanghe Nature Reserve, on a fallen angiosperm trunk, 21 November 2016, CLZhao 606 (**Holotype**, SWFC 000606).

Etymology: The specific epithet *puerensis* (Lat.) refers to the locality (Puer) of the type specimen.

Basidiomata annual, resupinate, adnate, without odor or taste when fresh, becoming corky upon drying, ≤5 × 3 cm, 2.5 mm thick at the center. Pore surface cream to buff when fresh, yellow to ochraceous upon drying; pores

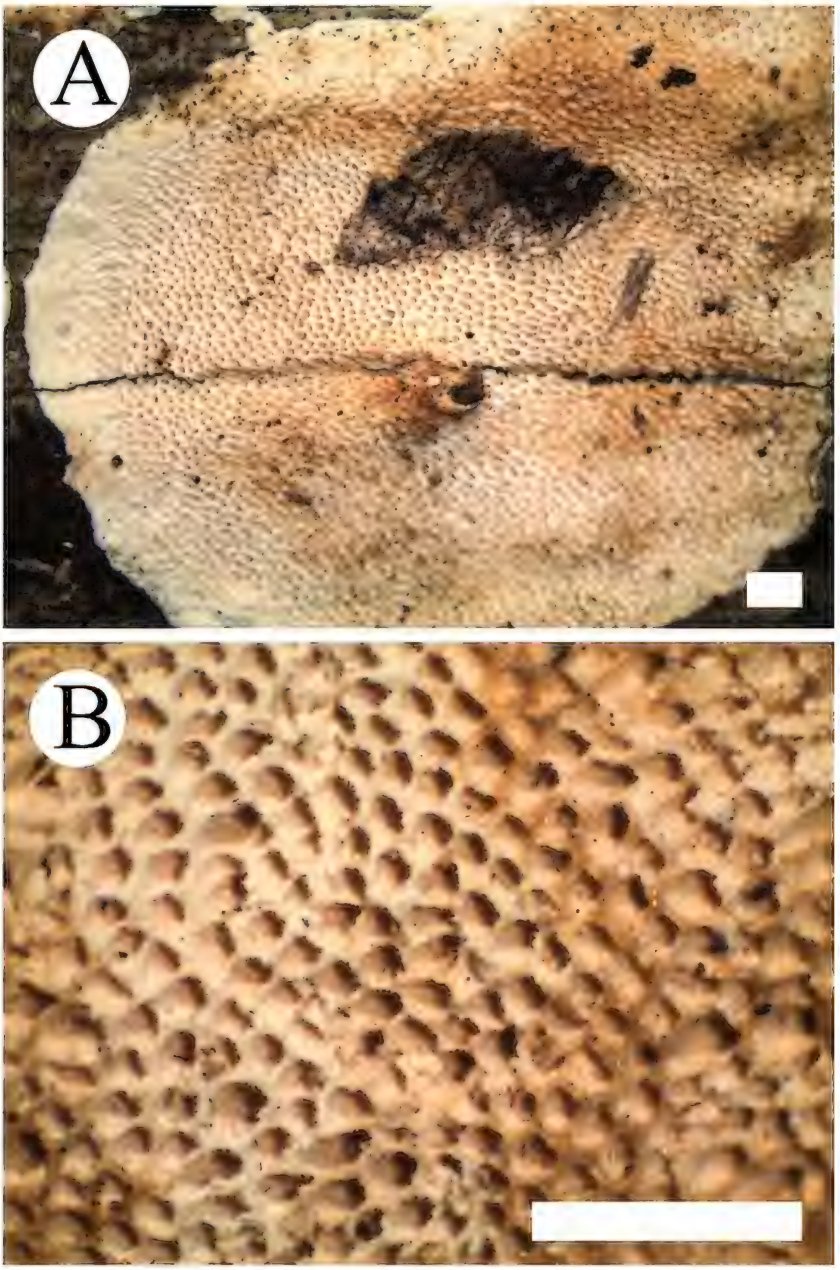

Fig. 1. *Perenniporia puerensis* (holotype, SWFC 000606): basidiomata. Scale bars = 1 cm.

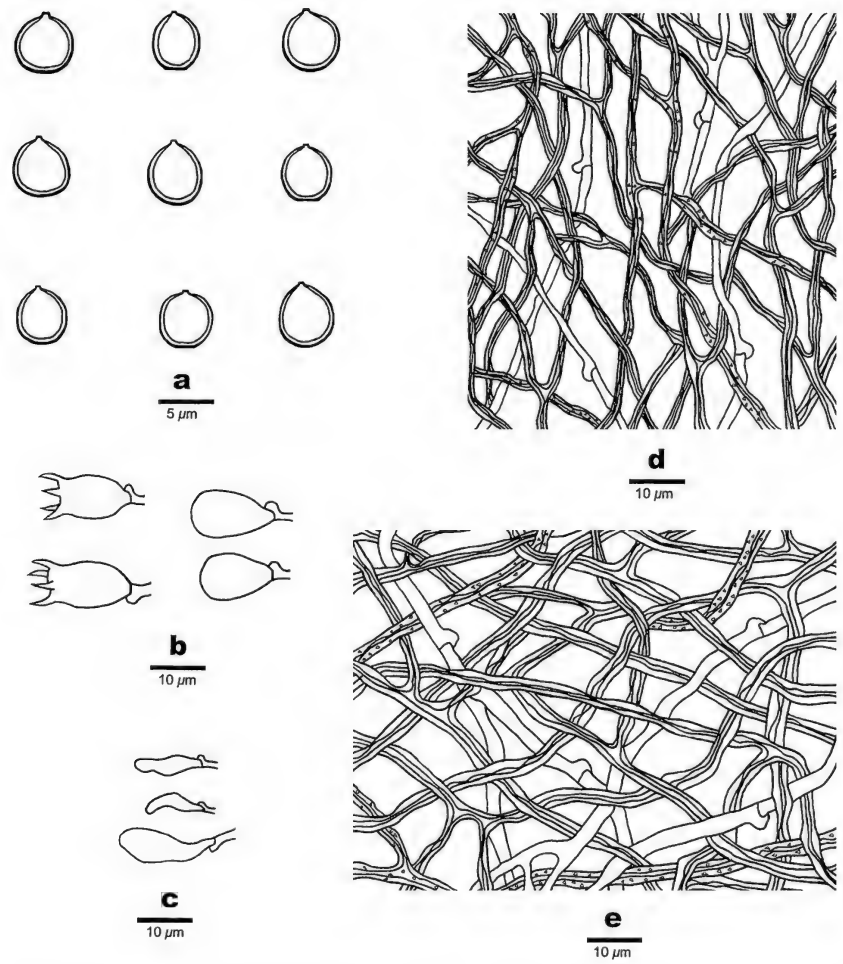

Fig. 2. *Perenniporia puerensis* (holotype, SWFC 000606). a. Basidiospores; b. Basidia and basidioles; c. Cystidioles; d. Hyphae from trama; e. Hyphae from subiculum. Scale bars: a = 5 μm; b–e = 10 μm.

round to angular, 4–6 per mm; dissepiments thin, entire. Sterile margin narrow, cream, ≤1 mm wide. Subiculum cream to buff, thin, ≤0.5 mm thick. Tubes concolorous with pore surface, corky, ≤2 mm long.

Hyphal structure dimitic; generative hyphae with clamp connections; skeletal hyphae M–, CB+; tissues unchanged in KOH and the pale-yellow crystals dissolving in KOH.

Subiculum generative hyphae infrequent, hyaline, thin-walled, frequently branched, 2–3.5 µm diam.; skeletal hyphae dominant, hyaline, thick-walled with a wide to narrow lumen, frequently branched, interwoven, 2.5–4.5 µm diam., encrusted with pale-yellow crystals.

Tube generative hyphae infrequent, hyaline, thin-walled, frequently branched, 2–3 µm diam.; skeletal hyphae dominant, hyaline, thick-walled with a wide lumen, frequently branched, interwoven, 2–4 µm diam., encrusted with pale-yellow crystals. Cystidia absent, fusoid cystidioles present, hyaline, thin-walled, 10–16 × 2.5–5 µm. Basidia barrel-shaped, with four sterigmata and a basal clamp connection, 13–18 × 7–10 µm; basidioles dominant, mostly pear-shaped, but slightly smaller than basidia.

Basidiospores ovoid to subglobose, either truncate or non-truncate, hyaline, thick-walled, smooth, non-dextrinoid, CB+, (4.1–)4.3–5.5(–5.7) × (3.5–)3.7–4.7(–5.1) µm, L = 4.95 µm, W = 4.18 µm, Q = 1.14–1.21 (n = 120/4).

Type of rot: white rot.

Additional specimens examined: **CHINA. Yunnan province. Puer:** Laiyanghe Nature Reserve, on fallen angiosperm trunk, 21 November 2016, CLZhao 607 (SWFC 000607); CLZhao 608 (SWFC 000608); CLZhao 609 (SWFC 000609).

Discussion

Four other *Perenniporia* species were also found with *P. puerensis* in the same locality (Yunnan province, China): *P. aridula* B.K. Cui & C.L. Zhao, *P. bannaensis* B.K. Cui & C.L. Zhao, *P. piceicola* Y.C. Dai, and *P. russeimarginata* B.K. Cui & C.L. Zhao. *Perenniporia aridula* is distinguished by its perennial basidiomata and larger basidiospores (6–7 × 5.1–6 µm, Zhao et al. 2013); *P. bannaensis* is distinguished by its smaller pores (6–8 per mm), unbranched skeletal hyphae, and strongly dextrinoid basidiospores (Zhao et al. 2013); *P. piceicola* differs by larger basidiospores (11–14 × 5.4–7.5 µm) and the presence of pyriform cystidia (Dai et al. 2002); and *P. russeimarginata* is separated by its perennial basidiocarps with a white to cream pore surface and the distinct reddish brown sterile margin (Zhao & Cui 2013a).

The presence of both truncate and non-truncate basidiospores is reminiscent of two similar *Perenniporia* species—*P. straminea* (Bres.) Ryvarden and *P. tibetica* B.K. Cui & C.L. Zhao: *P. straminea* is distinguished by smaller pores (7–9 per mm) and basidiospores (3–4 × 2.5–3 µm; Ryvarden 1988), while *P. tibetica* differs in its bigger pores (2–3 per mm) and presence of white to cream-colored rhizomorphs (Cui & Zhao 2012).

Perenniporia subacida (Peck) Donk, which resembles *P. puerensis* in pore size (4–6 per mm) and non-dextrinoid basidiospores, is distinguished by its

perennial basidiocarps, strongly dextrinoid skeletal hyphae, and non-truncate basidiospores (Núñez & Ryvarden 2001, Ryvarden & Melo 2014).

Polypores are an extensively studied group in *Basidiomycota* (Gilbertson & Ryvarden 1987, Núñez & Ryvarden 2001, Ryvarden & Melo 2014), but Chinese polypore diversity is still not well known, especially in the subtropics and tropics where many recently described taxa have been collected (Cui & Dai 2008; Cui et al. 2009, 2010, 2011; Du & Cui 2009; Li & Cui 2010; He & Li 2011; Jia & Cui 2011; Yu et al. 2013; Yang & He 2014; Chen et al. 2015). The new species *Perenniporia puerensis* is also from the subtropics. We anticipate that additional polypore taxa will be found in China after further investigation and molecular analyses.

Acknowledgments

Special thanks are due to Dr. Sana Jabeen (University of Education, Pakistan) and Jason Karakehian (Harvard University, USA) who reviewed the manuscript. We express our gratitude to Yong-He Li (Yunnan Academy of Biodiversity, Southwest Forestry University) for his support on molecular work and Kai-Yue Luo, Zhen Xu, and Ting Zeng (College of Biodiversity Conservation and Utilization, Southwest Forestry University) for their collection support. The research is supported by the National Natural Science Foundation of China (Project No. 31700023), and the Science Foundation of Southwest Forestry University (Project No. 111715) and the Science and Technology Talent Support Program of Three Areas in Yunnan Province (Project No. 21700329).

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MYCOTAXON

ISSN (print) 0093-4666 (online) 2154-8889 Mycotaxon, Ltd. ©2017

October–December 2017—Volume 132, pp. 875–879

https://doi.org/10.5248/132.875

Sporidesmiopsis lushanensis sp. nov. from Lushan Mountain, China

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Abstract—*Sporidesmiopsis lushanensis* is described and illustrated as a new species from dead stems of an unidentified broadleaf tree in Jiangxi Province, China. The fungus is characterized by macronematous conidiophores with apical branches and conidiogenous cells arising from stipe and branches with 6–7-euseptate conidia. A key to *Sporidesmiopsis* species is provided.

Key words—hyphomycetes, taxonomy, *Sordariales*

Introduction

Sporidesmiopsis Subram. & Bhat, established in 1989 with *S. malabarica* Subram. & Bhat as type species, is distinguished from *Sporidesmium* Link by its apically branched mononematous conidiophores and conidiogenous cells produced on both stipe and branches (Subramanian & Bhat 1989, Wongsawas et al. 2008). However, *S. malabarica* was subsequently determined to be a synonym of the earlier *Brachysporiella dennisii* J.L. Crane & Dumont, which was transferred to *Sporidesmiopsis* as *S. dennisii* (J.L. Crane & Dumont) Bhat et al. (Bhat & Kendrick 1993). Five other species have been described in the genus: *S. goanensis* Bhat & W.B. Kendr., *S. guangxiensis* J.W. Xia & X.G. Zhang, *S. malloti* J.W. Xia & X.G. Zhang, *S. pluriseptata* J.S. Monteiro et al., and *S. zhejiangensis* Wongs.

et al. (Bhat & Kendrick 1993, Wongsawas et al. 2008, Xia et al. 2014, 2015, Monteiro et al. 2016), but *S. zhejiangensis* was subsequently transferred to *Ellisembiopsis* Santa Izabel & Gusmão, due to its distoseptate conidia (Santa Izabel et al. 2013). Thus, only five species are currently accepted in *Sporidesmiopsis*.

Among our fungal collections from Lushan Mountain, a hyphomycetous specimen with the morphological characteristics of *Sporidesmiopsis* was collected, which we describe here as a new species, *S. lushanensis*. Type specimens are conserved in the Herbarium of Department of Plant Pathology, Shandong Agricultural University, Taian, China (HSAUP) and Herbarium Mycologium, Institute of Microbiology, Chinese Academy of Sciences, Beijing, China (HMAS).

Sporidesmiopsis lushanensis J.W. Xia & X.G. Zhang, **sp. nov.** FIG. 1

MycoBank MB 823681

Differs from *Sporidesmiopsis goanensis*, *S. guangxiensis*, and *S. malloti* by its wider conidia.

Type: China, Jiangxi Province: Lushan Mountain, on dead stems of an unidentified broadleaf tree, 25 Oct. 2016, J.W. Xia (**Holotype**, HSAUP H6725; **isotype**, HMAS 245644).

Etymology: in reference to the type locality.

Colonies on the natural substrate effuse, brown to dark brown, hairy. Mycelium superficial and partly immersed, composed of septate, pale brown, smooth hyphae, 1–2 µm diam. Conidiophores distinct, single, branched, erect, straight or slightly flexuous, cylindrical, smooth, thick-walled, brown to dark brown, 8–15-septate, 250–450 × 10–14 µm. Conidiogenous cells monoblastic, integrated and discrete, cylindrical, truncate at the apex after conidium secession, 12.5–20 × 5–7 µm. Conidia solitary, dry, fusiform, base truncate, apex rounded, brown to dark brown, 30–50 × 11.5–15.5 µm, 6–7-euseptate.

Comments—Three *Sporidesmiopsis* species differ from *S. lushanensis* by their narrower conidia: *S. goanensis* (5–7 µm; Bhat & Kendrick 1993), *S. guangxiensis* (6–7.5 µm; Xia et al. 2014), and *S. malloti* (8.5–11.5 µm; Xia et al. 2015). *Sporidesmiopsis dennisii* and *S. pluriseptata* differ from *S. lushanensis* by their longer conidia with much more numerous septa (see Fig. 2).

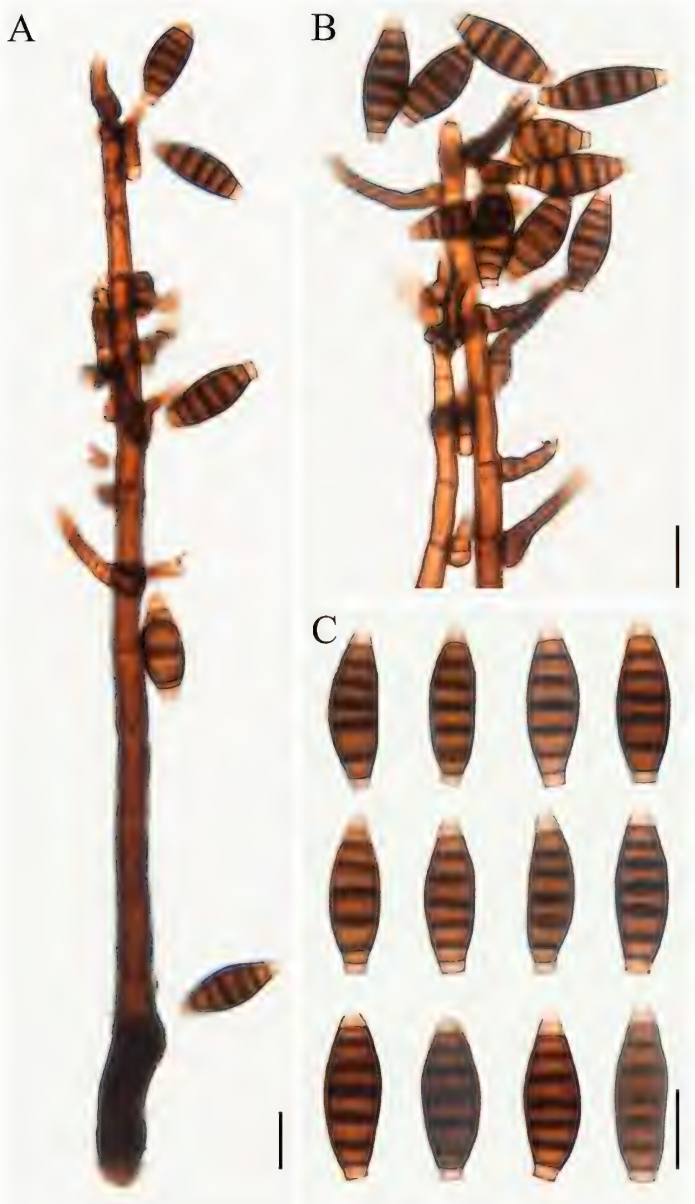

Fig. 1. *Sporidesmiopsis lushanensis* (holotype, HSAUP H6725).
A, B. Conidiophores, conidiogenous cells, and conidia; C. Conidia. Scale bars = 20 μm.

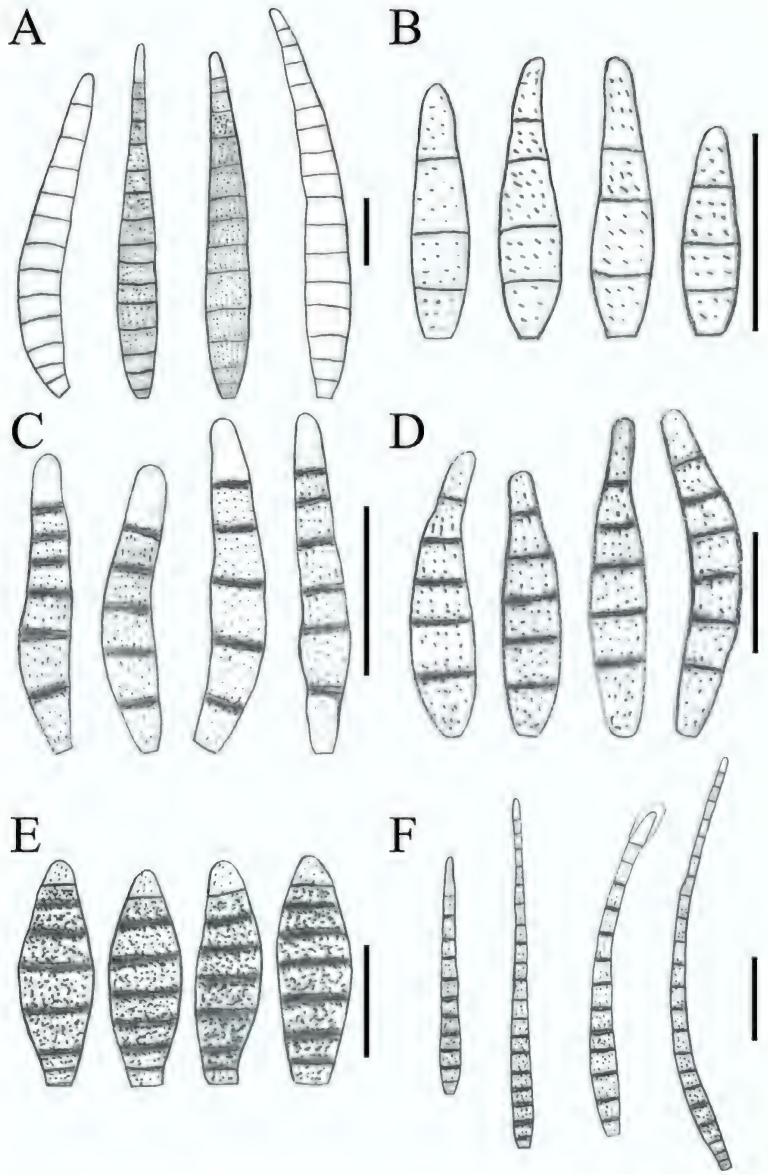

Fig. 2. *Sporidesmiopsis* spp., representative conidia (re-drawn from the literature). A. *S. dennisii* (Subramanian & Bhat 1989, as *S. malabarica*); B. *S. goanensis* (Bhat & Kendrick 1993); C. *S. guangxiensis* (Xia et al. 2014); D. *S. malloti* (Xia et al. 2015); E. *S. lushanensis* (this work); F. *S. pluriseptata* (Monteiro et al. 2016). Scale bars = 20 μm.

Key to species of *Sporidesmiopsis*

1. Conidia ≥10-euseptate 2
1. Conidia ≤7-euseptate 3
2. Conidia 69–92 × 9–13 µm, 10–15-euseptate ..... *S. dennisii*
2. Conidia 80–130 × 6–8.5 µm, 10–15-euseptate ..... *S. pluriseptata*
3. Conidia fusiform, 30–50 × 11.5–15.5 µm, 6–7-euseptate ..... *S. lushanensis*
3. Conidia obclavate to fusiform, ≤11.5 µm diam. 4
4. Conidia 20–30 × 5–7 µm, 3–4-euseptate ..... *S. goanensis*
4. Conidia ≥32 µm long 5
5. Conidia 32–40 × 6–7.5 µm, 5–6-euseptate ..... *S. guangxiensis*
5. Conidia 35–60 × 8.5–11.5 µm, 3–7-euseptate ..... *S. malloti*

Acknowledgments

The authors express gratitude to Dr. Jian Ma and Dr. Rafael F. Castañeda-Ruiz for serving as pre-submission reviewers and for their valuable comments and suggestions. This project was supported by the National Natural Science Foundation of China (Nos. 30600003, 31093440, 31230001) and the Ministry of Science and Technology of the People's Republic of China (Nos. 2006FY120100).

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MYCOTAXON

ISSN (print) 0093-4666 (online) 2154-8889 Mycotaxon, Ltd. ©2017

October–December 2017—Volume 132, pp. 881–884

https://doi.org/10.5248/132.881

Repetophragma elegans sp. nov. from Hainan Province, China

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Abstract—A new species, *Repetophragma elegans*, is described and illustrated from specimens collected on dead branches in Hainan Province, China. The fungus is characterized by subcylindrical to subfusiform 14–18-euseptate brown conidia with rounded apices, apical mucilaginous tunica, and truncate bases.

Key words—conidial fungi, taxonomy

Introduction

During our ongoing survey of microfungi associated with woody debris in tropical forests of Hainan Province, China, an undescribed species with the morphological characteristics of the genus *Repetophragma* Subram. was collected on the dead stems of an unidentified broadleaf tree.

Materials & methods

Collected samples of woody debris were placed in separate zip-lock plastic bags, taken to the laboratory, and incubated at 27°C for more than 2 weeks in an artificial climate box in 9-cm-diam. plastic Petri dishes containing moistened filter paper. Samples were examined under an Olympus SZ61 dissecting microscope. At least 50 mature conidia and 30 conidiophores were mounted in lactophenol, measured at 600× and 1000× magnifications, and photographed with an Olympus BX53 microscope. Adobe

Fig. 1. *Repetophragma elegans* (holotype, HSAUP H6478). Conidiophores, conidiogenous cells, and conidia.

Photoshop 7.0 was used to prepare the photographic images, and the backgrounds were replaced for esthetic reasons. Type specimens were deposited in the Herbarium of Department of Plant Pathology, Shandong Agricultural University, Taian, China (HSAUP) and the Mycological Herbarium, Institute of Microbiology, Chinese Academy of Sciences, Beijing, China (HMAS).

Taxonomy

Repetophragma elegans J.W. Xia & X.G. Zhang, **sp. nov.** FIG. 1

MycoBank MB 821043

Differs from *Repetophragma calongei* by its wider conidia, with an apical mucilaginous tunica.

Type: China, Hainan Province, Diaoluo Mountain, on dead stems of an unidentified broadleaf tree, 10 Apr. 2014, J.W. Xia (**Holotype**, HSAUP H6478; **isotype**, HMAS 245642).

Etymology: *elegans*, referring to elegant, describing the conidia.

Colonies on natural substrate effuse, brown to dark brown, hairy. Mycelium partly superficial, partly immersed in the substrate, composed of septate, pale brown, smooth, 2–4 µm diam. hyphae. Conidiophores macronematous, mononematous, unbranched, erect, straight to slightly flexuous, cylindrical, smooth, thick-walled, brown to dark brown, up to 5-septate, 13.5–50 × 6.5–9.5 µm. Conidiogenous cells monoblastic, terminal, indeterminate, brown to dark brown, cylindrical, with 1–5 annellidic percurrent extensions, 6–13.5 × 6–7 µm. Conidial secession schizolytic. Conidia solitary, straight or slightly curved, subcylindrical to subfusiform, smooth-walled, brown to dark brown, 14–18-euseptate, 75–115 × 12.5–15.5 µm (excluding mucilage), apex rounded, with an apical mucilaginous tunica, truncate at the base, 6–7 µm diam.

Comments—*Repetophragma* was introduced by Subramanian (1992) to accommodate *Sporidesmium*-like species that produced conidiogenous cells with annellidic percurrent extensions and euseptate conidia. Castañeda-Ruiz et al. (2011) redisposed taxa in *Repetophragma*. According to Index Fungorum (2017) a total of 35 species are included in *Repetophragma*.

Repetophragma elegans is morphologically similar to *R. calongei* J. Mena et al. in conidial shape. However, *R. calongei* can be easily separated by its narrower conidia (8–10.5 µm) without an apical mucilaginous tunica (Silvera-Simón et al. 2009).

Acknowledgments

The authors express gratitude to Dr. Rafael F. Castañeda-Ruiz and Dr. Jian Ma for serving as pre-submission reviewers and for their valuable comments and suggestions.

This project was supported by the National Natural Science Foundation of China (Nos. 30600003, 31093440, 31230001, 31493010, 31493011) and the Ministry of Science and Technology of the People's Republic of China (No. 2006FY120100).

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MYCOTAXON

ISSN (print) 0093-4666 (online) 2154-8889 Mycotaxon, Ltd. ©2017

October–December 2017—Volume 132, pp. 885–893

https://doi.org/10.5248/132.885

A contribution to the study of *Helotiales* and *Rhytismatales* in Turkey

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Abstract—*Naemacyclus fimbriatus*, *Lophodermium juniperinum*, and *Marssonina daphnes* have recently been discovered in Turkey. This is the first record of *Naemacyclus* from Turkey. Morphological data obtained by light and scanning electron microscopy of these fungi are presented.

Key words—acervular anamorph, *Ascomycota*, new host, new records, SEM

Introduction

Rhytismatales are an order of endophytic, parasitic, or saprotrophic fungi in *Leotiomycetes* (*Ascomycota*), the inoperculate discomycetes. Especially common on conifers, grasses and members of *Ericaceae,* they are also found on other vascular plants. The species disperse by ascospores and at least in temperate regions usually infect their hosts in spring/summer to develop fruiting bodies the next year on dead material (Lantz et al. 2011). The order includes plant parasitic fungi causing serious needle cast, such as *Lophodermium seditiosum* Minter et al. on *Pinus sylvestris* (Minter 1981b)., Rhytismatalean fungi the members of *Rhytismatales* are poorly known in Turkey and have not been yet intensively studied.

Within *Leotiomycetes, Helotiales* represents the largest order of inoperculate discomycetes—an ecologically and morphologically highly diverse group of

ascomycetes that also includes lichen-inhabiting (lichenicolous) species (Suija et al. 2015). At present the order comprises c. 4000 species of saprophytes, mycorrhizal fungi, root endophytes, and plant and fungal (including lichens) parasites (Schoch et al. 2009).

Materials & methods

Plant specimens infected with microfungi were collected from Erciyes Mountain in Kayseri province of Turkey. The host specimens were prepared following conventional herbarium techniques. Host plants were identified using the Flora of Turkey and East Aegean Islands (Davis 1965–85). Thin fungal sections prepared from host tissue were examined under a Leica DM E light microscope and measured from mounts in 5% KOH or tap water. Close-up photographs of infected host surface were done via Leica EZ4D stereomicroscope. The fungi were identified using relevant literature (for *Naemacyclus* – DiCosmo et al. 1984, Hou et al. 2006; for *Lophodermium* – Dennis 1981, Ellis & Ellis 1987; for *Marssonina* – Grove 1937, Ellis & Ellis 1987, Ignatavičiūtė & Treigienė 1998). All examined specimens were deposited in the Mycology Laboratory of Ahi Evran University, Department of Biology, Kırşehir, Turkey (C), under Gökhan Doğan (GD) collection numbers.

For scanning electron microscopy (SEM), 8–10 mm square pieces of infected leaf or cone scale were mounted on aluminium stubs with double-sided adhesive tape, coated with gold using Polaron SC 502 Sputter Coater, and examined using a Jeol JSM 6060 scanning electron microscope operated at 5–10 kV in the Electron Microscopy Unit, Gazi University (Turkey).

Taxonomy

Naemacyclus fimbriatus (Schwein.) DiCosmo, Peredo & Minter, Eur. J. For. Path. 13(4): 207 (1983) Pl. 1

Apothecia scattered, immersed to erumpent, sessile, circular to subcircular, 300–430 × 230–285 µm, dark brown to black. Asci cylindrical, short-stalked, thin-walled, 85–95 × 8.5–9.5 µm, rostrate at the apex, without circumapical thickening, discharging spores through a small apical pore, 8-spored. Ascospores fasciculate, filiform, (50–)54–80 × 2–2.2 µm, rounded at both ends, hyaline, (2–)5-septate, rarely aseptate, with mucous sheath. Paraphyses filiform, unbranched, septate, 90–105 × 1 µm, hyaline, covered by a thin mucous sheath.

Specimen examined—**TURKEY, Kayseri**, Erciyes mountain, Turkish World Forest, 38°36′12″N 35°30′56″E, 1850–1900 m asl., on fallen female cone scales of *Pinus nigra* L. (*Pinaceae*), 31.05.2010, G. Doğan (AEUT GD1069).

Notes: While DiCosmo et al. (1983) resolved the nomenclatural problems surrounding *N. fimbriatus,* the systematic position of this species is still

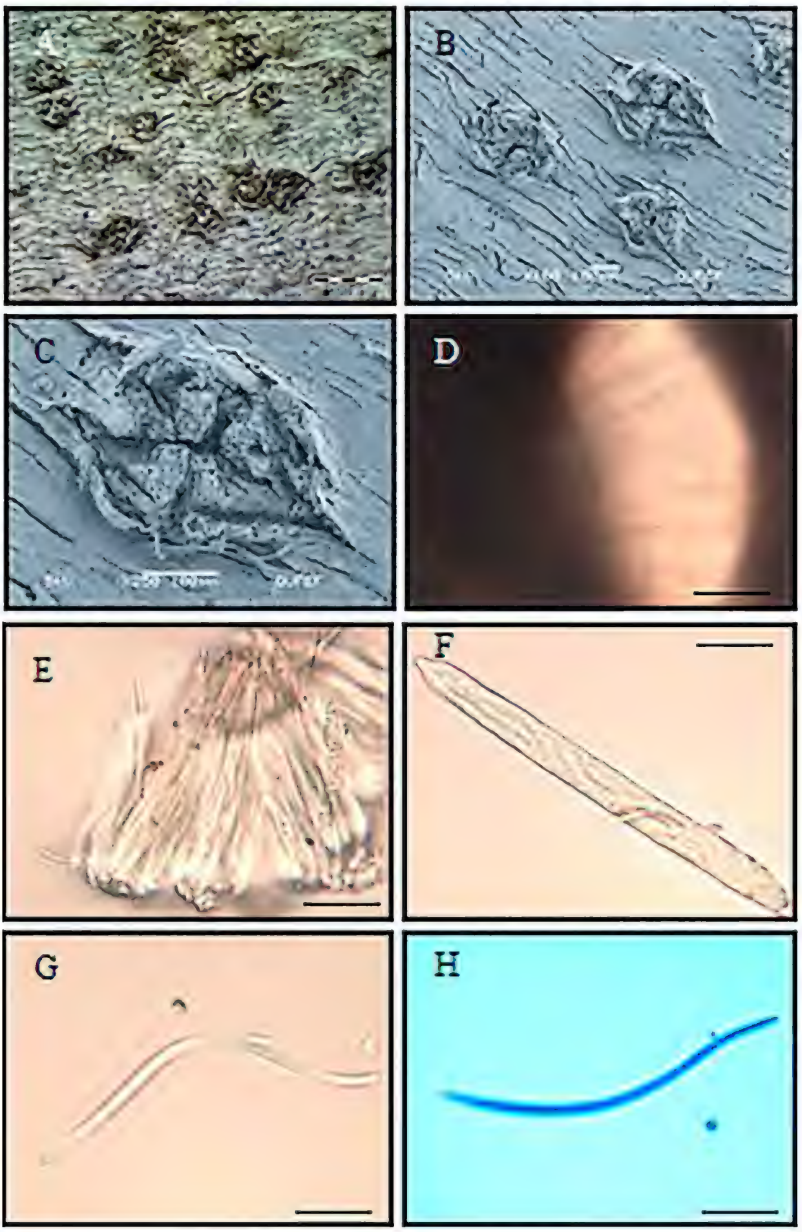

Plate 1. Microscopic characters of *Naemacyclus fimbriatus*. A: apothecia on cone scales; B, C: apothecia on cone scales (SEM); D: vertical section of an apothecium; E: asci and ascospores; F: ascus and ascospores; G: ascospore; H: lacto phenol cotton blue mount showing ascospore. Scale bars = D: 100 µm; E: 20 µm; F–H: 15 µm.

controversial. *Naemacyclus fimbriatus* was once placed in the *Phacidiaceae,* but DiCosmo (1979) suggested that it is more closely related to *Rhytismataceae* because of J– apical ring and ascospores covered by a mucous sheath (Kirk et al. 2001, Cannon & Kirk 2007). The recent analysis of the partial small subunit rDNA (Hou et al. 2006) indicates that *N. fimbriatus* is closely related to taxa in the *Helotiales*.

Although our Turkish specimen of *Naemacyclus fimbriatus* is morphologically similar to specimens described in literature (DiCosmo et al. 1984, Vujanovic et al. 1998, Hou et al. 2006), it does differ slightly in some aspects, particularly with respect to ascospore size and number of septa: 75–90 × 2–2.5 µm and 7-septate (DiCosmo et al. 1984); 78–91 × 2–2.5 µm and 7-septate (Vujanovic et al. 1998); 65–95 × 1–1.5 µm and (2–)4–6-septate (rarely aseptate) (Hou et al. 2006). The ascospores in the specimen from Turkey are shorter and (2–)5-septate (rarely aseptate).

Naemacyclus fimbriatus is widely distributed on *Pinus* spp. in Asia (China), Europe, and North America (Cannon et al. 1985; Dennis 1981; Dudka et al. 2004; Eriksson 2014; Gremmen 1960, as *Lasiostictis fimbriata*; Hanlin 1963, as *Stictis fimbriata*; Lin 2012; Minter 1981a; Sherwood 1979, as *Lasiostictis fimbriata*; Vujanovic et al. 1998). The genus *Naemacyclus* and *N. fimbriatus* are reported for the first time from Turkey.

Lophodermium juniperinum (Fr.) De Not., G. Bot. Ital. 2(7–8): 46 (1847) Pl. 2

Apothecia hysterioid, elliptical, blister-like, strongly raised above the surface of needles, 600–650 × 200–220 µm, blackish; disc soft, whitish. Asci cylindrical-clavate, short-stalked, thin-walled, 95–110 × 13.5–15.5 µm, 8-spored; Ascospores fasciculate, filiform, attenuated at both ends, 65–87 × 1.5–3 µm, guttulate, hyaline, with a thin hyaline gelatinous coating. Paraphyses slender, filiform, hyaline, swollen and curled at the tip.

Specimen examined—**TURKEY, Kayseri**, Erciyes mountain, Develi, 2000–2050 m asl., conifer plantation area, on dead leaves of *Juniperus communis* L. (*Cupressaceae*), 25.07.2011, G. Doğan (AEUT GD1106).

Notes: Ten rhytismataceous ascomycetes from the genera *Coccomyces*, *Colpoma*, *Hypoderma*, *Lophodermium*, *Pseudophacidium*, *Soleella*, and *Tryblidiopsis* have been reported on species of *Juniperus*; those on juniper needles are mostly pathogenic, causing needle cast (Hou et al. 2005). *Lophodermium juniperinum* is probably weakly parasitic, capable of endophytic growth in needles for part of its life cycle, like most species of *Lophodermium* (Minter 1981b).

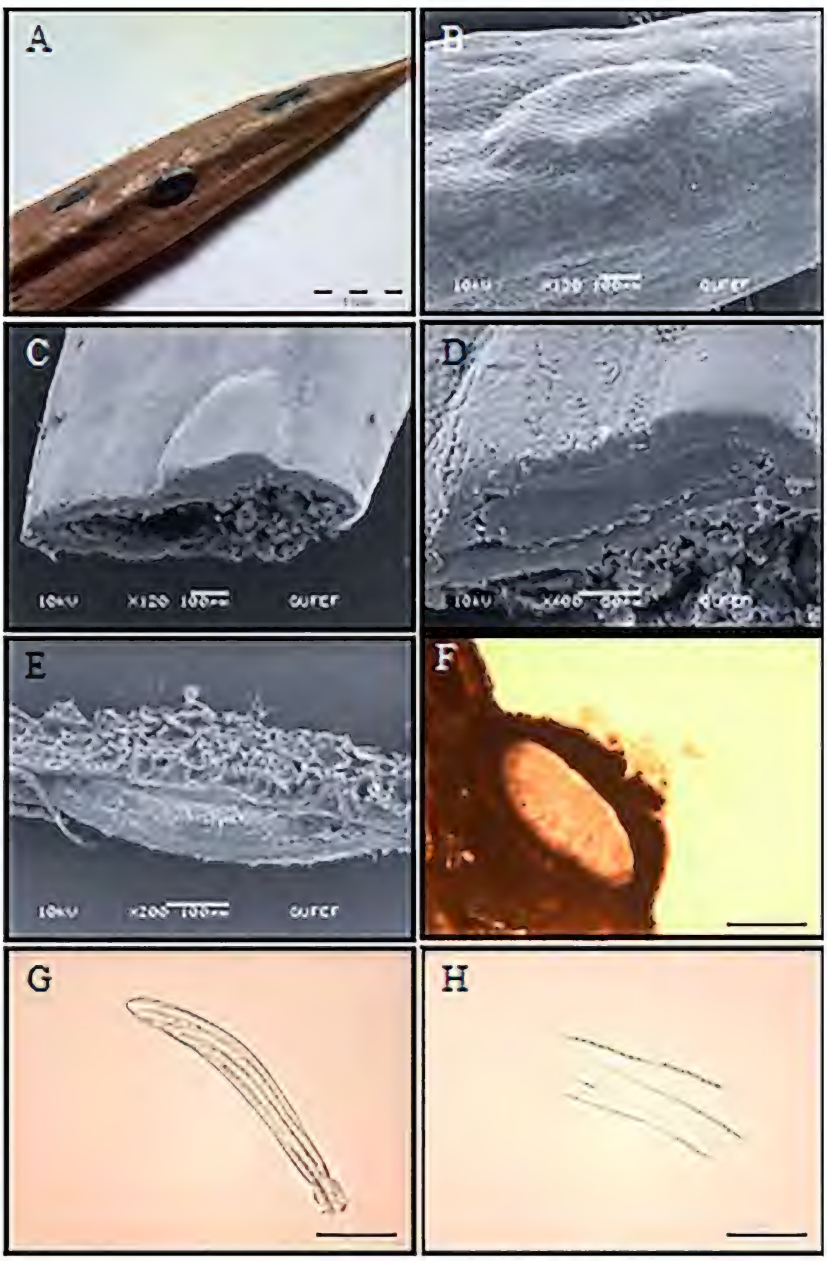

Plate 2. Microscopic characters of *Lophodermium juniperinum*. A: apothecia on leaf; B: apothecium on leaf (SEM); C-E: vertical section of an apothecium (SEM); F: vertical section of an apothecium; G: ascus and ascospores; H: ascospores. Scale bars = F: 200 µm; G,H: 25 µm.

The Turkish specimen of *L. juniperinum* agrees with other reports of the species in ascomata, asci and ascospores morphology; the only observable difference being the smaller dimensions of ascomata, asci, and ascospores. Dennis (1981) describes 1 × 0.4 mm apothecia, 130 × 17 µm asci, and 60–100 × 2 µm ascospores; Ellis & Ellis (1987) cite 1 mm long apothecia and 60–90 × 2 µm ascospores.

Lophodermium juniperinum is known from Asia (Dudka et al. 2004), Europe, and North America (Hou et al. 2005). This species is reported for the first time from Turkey.

Marssonina daphnes (Roberge ex Desm.) Magnus, Hedwigia 45: 89 (1906) Pl. 3

Leaf spots amphigenous, irregularly rounded, 1–3 mm diam., greenish and then brownish. Conidiomata acervular, amphigenous, at first immersed in host tissue, later erumpent, small, pale brown. Conidia ovoid to pyriform, slightly curved, 15–20 × 6.5–8 µm, when mature with transverse septum near the base, not constricted, obtuse at the apex, truncate at the base, with numerous guttulations, hyaline.

Specimen examined—**TURKEY**, **Kayseri**, Erciyes mountain, Kayseri memorial forest, 38°36′13″N 35°30′58″E, 1870 m asl., on living leaves of *Daphne oleoides* Schreb. subsp. *oleoides* (*Thymelaeaceae*), 25.07.2011, G. Doğan (AEUT GD1080).

Notes: *Marssonina daphnes* is the causal agent of the daphne anthracnose, which usually causes little damage. The Turkish specimen of *Marssonina daphnes* is morphologically similar to specimens described in literature (Grove 1937, Ellis & Ellis 1987, Ignatavičiūtė & Treigienė 1998). However, the conidia of the Turkish samples are wider than the British collection (12–20 × 4–5 µm; Grove 1937), while those reported by Ignatavičiūtė & Treigienė (1998) are slightly narrower and shorter than our specimen.

Marssonina daphnes is distributed on *Daphne* spp. in Asia (Japan), Australasia, Europe, and North America (Conners 1967; Ginns 1986; Cook & Dubé 1989; Kobayashi 2007; Pennycook & Galloway 2004; Piątek & Wołczańska 2004; Shaw 1973). The species is reported for the first time from Turkey, and *Daphne oleoides* Schreb. subsp. *oleoides* represents a new host record.

Acknowledgments

We are grateful to Dr. Eugene Yurchenko, and Sevda Kırbağ for serving as pre-submission reviewers, to Dr. Pennycook for nomenclatural review.

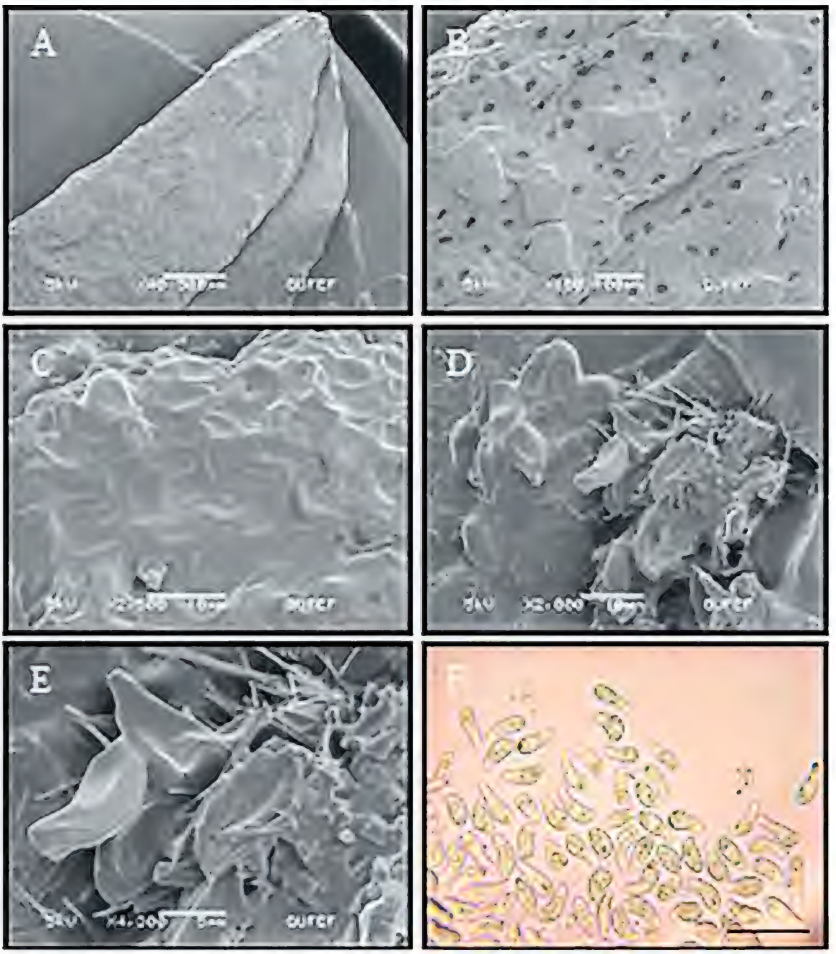

Plate 3. Microscopic characters of *Marssonina daphnes*. A,B: acervulus on leaf (SEM); C–E: Conidia (SEM); F: Conidia. Scale bar = 10 µm.

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MYCOTAXON

ISSN (print) 0093-4666 (online) 2154-8889 Mycotaxon, Ltd. ©2017

October–December 2017—Volume 132, pp. 895–901

https://doi.org/10.5248/132.895

Huneckia pollinii and *Flavoplaca oasis* newly recorded from China

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Abstract—*Huneckia pollinii* and *Flavoplaca oasis* are described and illustrated from Chinese specimens. The two species and the genus *Huneckia* are recorded for the first time from China.

Keywords—Asia, lichens, taxonomy, *Teloschistaceae*

Introduction

Teloschistaceae Zahlbr. is one of the larger families of lichenized fungi. It includes three subfamilies, *Caloplacoideae*, *Teloschistoideae*, and *Xanthorioideae* (Gaya et al. 2012; Arup et al. 2013). Many new genera have been proposed based on molecular phylogenetic investigations (Arup et al. 2013; Fedorenko et al. 2012; Gaya et al. 2012; Kondratyuk et al. 2013, 2014a,b, 2015a,b,c,d). Currently, the family contains approximately 79 genera (Kärnefelt 1989; Arup et al. 2013; Kondratyuk et al. 2013, 2014a,b, 2015a,b,c,d; Søchting et al. 2014a,b).

Huneckia S.Y. Kondr. et al. was described in 2014 (Kondratyuk et al. 2014a) based on morphological, anatomical, chemical, and molecular data. It is characterized by continuous to areolate thalli, paraplectenchymatous cortical

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layers, biatorine apothecia, *Blastenia*-type true exciples, narrowly bacilliform conidia, and the presence of chrysophanol, rhein, and chrysophanal. *Huneckia* is similar to *Blastenia* A. Massal. but differs by having ascospores with very thick cell walls at the poles and in the secondary chemistry (Kondratyuk et al. 2014a). *Huneckia* includes two species, *H. pollinii* and *H. rheinigera* (Elix & S.Y. Kondr.) S.Y. Kondr et al. (Kondratyuk et al. 2014a). No species of *Huneckia* have been reported from China .

Flavoplaca Arup et al., described in 2013 (Arup et al. 2013), is characterized by yellow crustose or squamulose thalli, orange zeorine apothecia, polaribilocular spores with medium to long spore septa, and bacilliform to ellipsoid conidia. The genus is rather similar to *Xanthoria* (Fr.) Th. Fr. and *Caloplaca* Th. Fr. in some characters, but forms a very well delimited clade with many species that are often sorediate. *Flavoplaca* includes about 27 species (Arup et al. 2013).

During our research on the taxa of *Teloschistaceae* in China, we identified two species as new to the country: *Huneckia pollinii* and *Flavoplaca oasis*.

Materials & methods

The specimens, which were collected in Guizhou Province and Inner Mongolia, are preserved in the Lichen Section of the Botanical Herbarium, Shandong Normal University, Jinan, China (SDNU) and the Lichens Research Center in Arid Zones of Northwestern China, Xinjiang University, Wulumuqi, China (XJU). The morphological and anatomical characters were examined under a COIC XTL7045B2 stereo microscope and an Olympus CX41 polarizing microscope. Thalli and medullae were tested with K (10% aqueous solution of potassium hydroxide) and C (a saturated solution of aqueous sodium hypochlorite) for identification. Calcareous and non-calcareous rocks were determined by application of concentrated HCl. The lichen substances were identified using standardized thin layer chromatography techniques (TLC) with solvent system C (Orange et al. 2010). Photos were taken using Olympus SZX16 stereo and BX61 research microscopes attached to an Olympus DP72 camera.

Taxonomic descriptions

Huneckia pollinii (A. Massal.) S.Y. Kondr., Kärnefelt, A. Thell, Elix, Jung Kim, A.S. Kondr. & Hur, Acta Bot. Hung. 56: 111 (2014). Fig. 1

Morphology—Thallus crustose, continuous, very thin to areolate at margin, grey to whitish grey. Apothecia biatorine, sessile, 0.3–1.0 mm diam.; disc dark brown to rust-brown; proper exciple consisting of radiating, thick walled long-septate cells, prosoplectenchymatous; exciple and epithecium K+ reddish violet; without crystals; epihymenium brown; hymenium colourless to pale brown, 74–90 μm high; hypothecium sand yellow, roundish to irregular shape, without oil droplets; paraphyses 2.2–3.0 μm wide, upper part

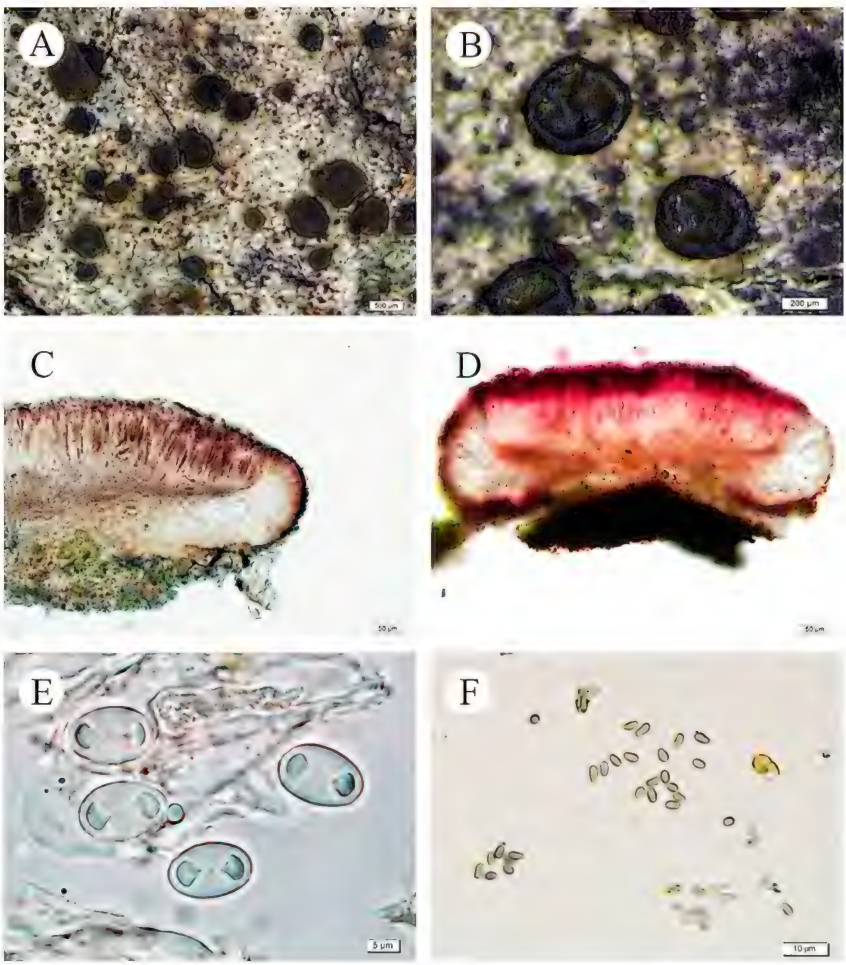

FIG. 1. *Huneckia pollinii* (SDNU 20160195). A: thallus; B: apothecia; C: apothecium section; D: strong red turning to purple K reaction of epihymenium; E: ascospores; F: conidia.

pigmented, without swollen tip, abundantly branching at tips. ASCI 8-spored, *Teloschistes*-type; ascospores polaribilocular, ellipsoid, mostly "sand-clock"-shaped; 13.2–19 × 7.5–9.6 μm, with cell walls 1–2(–2.5) μm thick (thickest at the poles); spore septum 2.9–5.7 μm. CONIDIA elliptical to narrowly bacilliform, 1.5–2.2 × 3.8–5.1 μm.

CHEMISTRY—Thallus and medulla K–, C–. Apothecia K+ purple, C+ red. Epihymenium K+ strong red, turning purple with coloured solution. Unknown substances 1 & 2 (TLC solvent system C Rf. 48 and Rf. 53).

Substrate—On wood or on smooth bark.

Distribution—*Huneckia pollinii* has been reported from the eastern United States, Europe, and Mexico (Wetmore 1994, Kondratyuk et al. 2014a). New to China.

Specimens examined: **CHINA. Guizhou**, Dejiang, Quankou town alt. 873 m, on bark, 2 June 2016, X.X. Zhao 20160195, 20160180 (SDNU).

Comments—*Caloplaca pollinii* var. *major* B. de Lesd. is similar to *Huneckia pollinii*, but differs in having concave brown young apothecia, black immarginate older apothecia, and larger spores (Bouly de Lesdain 1949). Specimens of *Caloplaca asserigena* (J. Lahm) Della Torre & Sarnth. that may be confused with *Huneckia pollinii*, can be distinguished by rust-red to red-brown discs and smaller ascospores.

Flavoplaca oasis (A. Massal.) Arup, Frödén & Søchting, Nordic J. Bot. 31: 46 (2013). Fig. 2

Morphology—Thallus usually visible but thin, with only some small granules or areole visible at thallus margin, pale yellow; alveolate cortex; algal layer always separated by fungal hyphae; without prothallus and vegetative propagules; isidia, soredia, and blastidia absent; medulla white. Apothecia pseudolecanorine or zeorine type, abundant, sessile, round or elliptical, 0.1–0.5 mm diam.; disc slightly convex, orange to dark orange, epruinose; proper margin very thin, slightly raised, paler than disc; amphithecium ± reduced, with numerous algae, cortex poorly developed; epihymenium granular, yellow; hymenium hyaline, 75–85 µm tall; paraphyses simple or slightly branched above, 1–2 apical cells thickened, up to 7 µm wide; hypothecium hyaline or inspersed, ±roundish, consisting of thin-walled roundish cells, 53–125 µm, without crystals or oil droplets, prosoplectenchymatous, hyphae irregular, 40–50 µm high. Exciple consisting of thin-walled oval to polygone cells, upper side 38–50 µm. Paraphysis mostly simple, rarely forked, swollen in and near the tip cells, 4.5–5.3 µm in wide. Asci 43–52 × 11–21 µm, 8-spored, *Teloschistes*-type. Ascospores polaribilocular, thin-walled, 8.5–13.5 × (4.0–)4.8–7.6 µm, spore septum wide, >¼ of spore length, 2.9–4.6 µm. Pycnidia not observed.

Chemistry—Thallus K+ purple, medulla K–, epihymenium K+ purple. Unknown substance (TLC solvent system C Rf. 51).

Substrate—On pure limestone, concrete.

Distribution—*Flavoplaca oasis*, which is widespread in Europe (Arup 2009), is also reported from western Asia (John et al. 2004) and North Africa

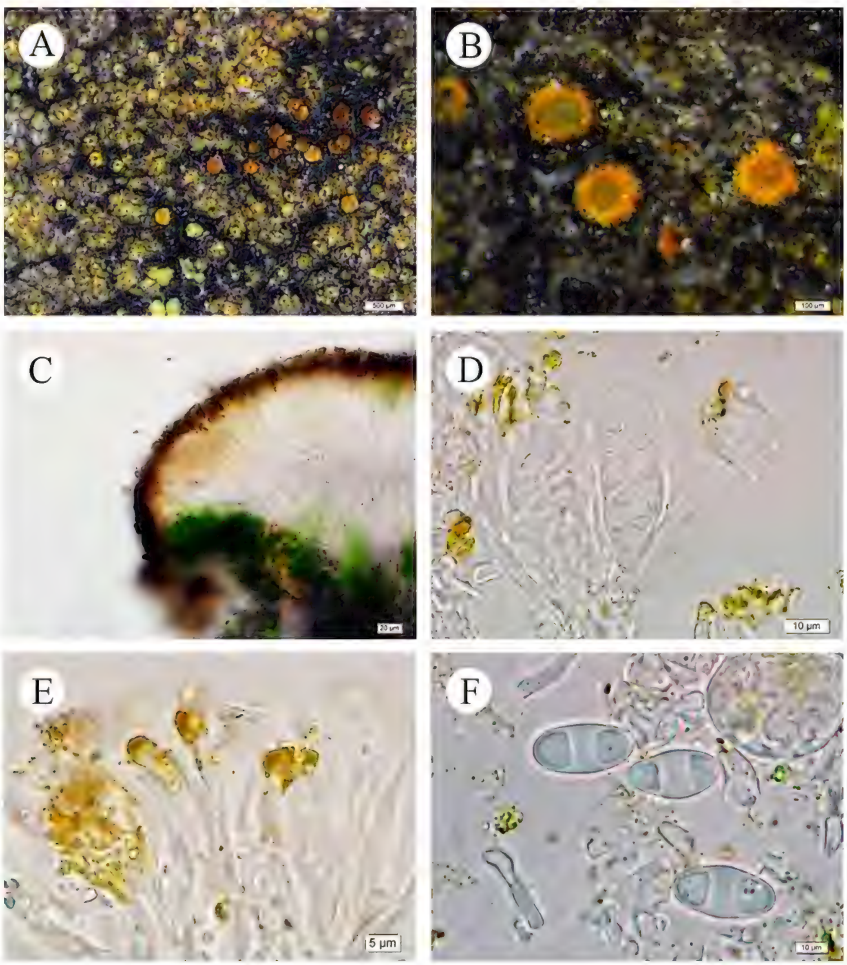

FIG. 2. *Flavoplaca oasis* (SDNU 20160086). A: thallus; B: apothecia; C: apothecium section; D: ascus and ascospores; E: paraphyses; F: ascospores.

(Thor & Nascimbene 2010). The species grows mainly on pure limestone, concrete, and mortar (Arup 2009), where it occurs as a free living or parasitic lichen growing on endolithic *Verrucaria* s.lat. (Wilk 2011). New to China.

SPECIMENS EXAMINED: **CHINA. GUIZHOU**, Dejiang, Jingangling, alt. 1100 m, on rocks, 26 May 2016, W.C. Wang , X.X. Zhao 20160086, 20160038, 20160814 (SDNU). **INNER MONGOLIA**, Daqing mountain, 41°54.60′N 111°47.71′E. alt. 1970 m, on rocks, 12 August 2014. 20141175-b (XJU).

Comments—*Flavoplaca oasis* is similar to *Athallia holocarpa* (Hoffm.) Arup et al., which is distinguished by its more yellow-tinged apothecia with thicker and more prominent proper margins and spores with a broader isthmus. Specimens of *F. oasis* may also be confused with *F. polycarpa* (A. Massal.) Arup et al., which can be distinguished by larger apothecia with thicker margins and more distinct, thicker orange thalli.

Acknowledgements

We thank Dr. Li-song Wang and Dr. Xin-yu Wang (Key Laboratory for Plant Diversity and Biogeography of East Asia, Kunming Institute of Botany, CAS) for providing great help during the study. We also thank Dr. Andre Aptroot (ABL Herbarium, Soest, Netherlands) and Dr. S.Y. Guo (Key Laboratory of Systematic Mycology and Lichenology Laboratory, Institute of Microbiology, CAS, Beijing, China) for presubmission review and providing great guidance during the study. This work was supported by the National Natural Science Foundation of China (31570017) and the Scientific Research Foundation of Graduate School of Shandong Normal University (SCX201629).

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MYCOTAXON

ISSN (print) 0093-4666 (online) 2154-8889 Mycotaxon, Ltd. ©2017

October–December 2017—Volume 132, pp. 903–907

https://doi.org/10.5248/132.903

Paliphora bicolorata sp. nov. from the Brazilian Atlantic Forest

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Abstract—A new species, *Paliphora bicolorata,* collected from decaying leaves of an unidentified plant, is described and illustrated. It is characterized by bicolored conidiophores with 3–4 dark reddish-brown distal cells and golden brown to brown lower cells and cylindrical-fusiform, 1-septate, hyaline conidia. A key to *Paliphora* species is provided.

Key words—neotropic, asexual fungi, systematics

Introduction

The genus *Paliphora* Sivan. & B. Sutton was introduced by Sivanesan & Sutton (1985) with *P. aurea* Sivan. & B. Sutton as type species; five more species were added by Kuthubutheen (1987), Alcorn (1996), Gusmão et al. (2008), and Goh et al. (2014). *Paliphora* is distinguished by distinct, unbranched, multiseptate, setiform conidiophores that form hispid golden brown to brown colonies and polytretic, integrated, determinate, intercalary (rarely terminal) conidiogenous cells with tretic loci (situated immediately below transverse septa) producing successive, cylindrical or somewhat subfusiform to subacerose, hyaline,

unicellular or euseptate conidia that accumulate in slimy masses around the conidiogenous cells. The production of successive conidia in dense mucous masses or packets through tretic loci is peculiar among hyphomycetes and serves as the main diagnostic character of *Paliphora* (Alcorn. 1996, Gusmão et al. 2008, Sivanesan & Sutton 1985).

During a mycological survey of microfungi associated with leaf litter in a Brazilian Atlantic forest, we collected a conspicuous fungus, described here as a new *Paliphora* species.

Materials & methods

Individual collections were placed in plastic bags, taken to the laboratory, and treated according to Castañeda-Ruiz et al. (2016). Mounts were prepared in polyvinyl alcohol-glycerol (8 g PVA in 100 ml of water, plus 5 ml of glycerol) and lactofuchsin (0.1 g acid fuchsin, 100 ml 85% lactic acid following Carmichael (1955) or in lactic acid (90%) and measurements were made at a magnification of ×1000 under a Nikon Eclipse Ni-U microscope with bright field optics; photomicrographs were obtained using DIC optics with a Nikon DS-Fi2 camera. The holotype was deposited in the Herbarium of Universidade Federal de Pernambuco, Recife, Brazil (URM).

Taxonomy

Paliphora bicolorata Malosso, P.M.O. Costa & R.F. Castañeda, **sp. nov.** Fig. 1

MycoBank MB 823671

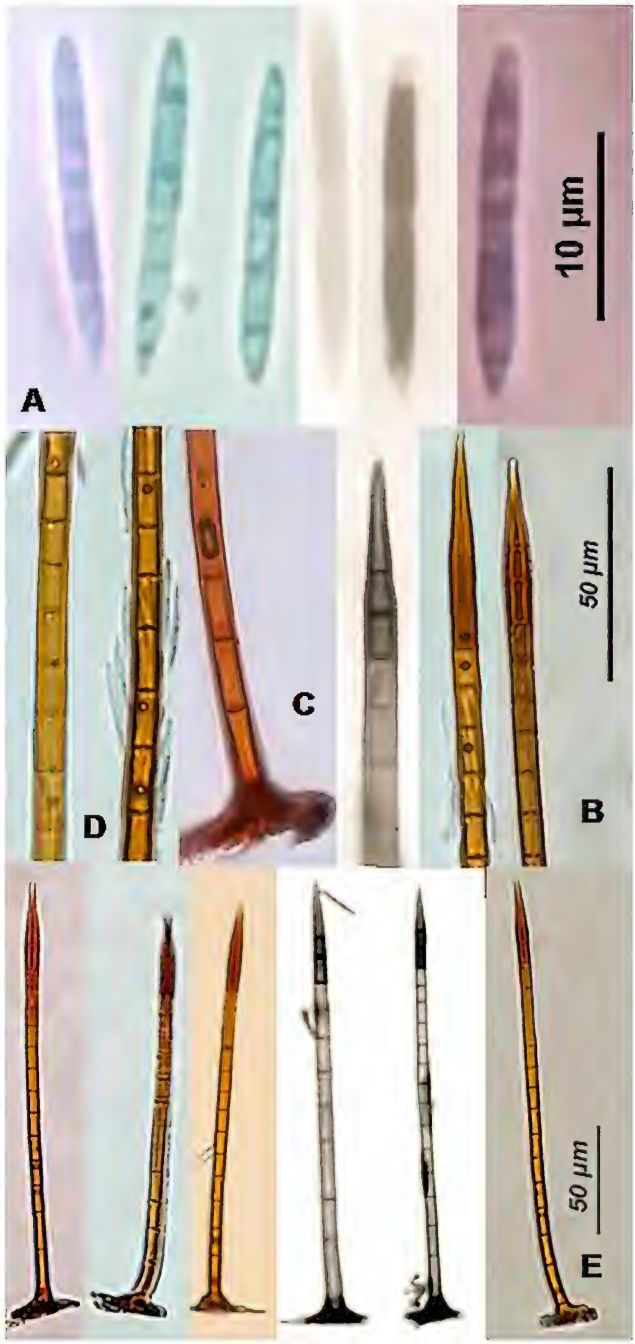
Differs from *Paliphora intermedia* by its bicolored conidiophores.

Type: Brazil, Pernambuco, Igarassú, RPPN Refúgio Ecológico Charles Darwin, 7°48′S 34°57′W, on decaying leaves of an unidentified plant, 12.V.2017, coll. P.M.O. Costa (**Holotype**, URM 90132).

Etymology: Latin, *bicolorata*, two-colored, referred to the conidiophores.

Colonies on the natural substrate effuse, hispid, reddish-brown to brown. Mycelium superficial and immersed, composed of septate, branched, brown, smooth-walled hyphae, 1.5–2.5 µm diam. Conidiophores macronematous, setiform, unbranched, erect, straight, cylindrical below, acuminate at the apex, ≤17-septate, golden brown below, reddish-dark brown at the four distal cells, smooth below, verruculose near the apex, 170–220 × 5–6 µm, slightly lobed at the base, 9–13 µm wide. Conidiogenous cells polytretic, intercalary, determinate, incorporated, brown, 7–10 × 4–5 µm. Conidia solitary,

Fig. 1. *Paliphora bicolorata* (ex holotype, URM 90132). A. Conidia; B. Conidiogenous cells and dark reddish-brown distal cell; C. Conidiophore basal cell; D. Intercalary conidiogenous cells with tretic loci and conidia; E. Conidiophores, conidiogenous cells, and conidia. B–D share the same scale.


A
10 µm
B
C
D
50 µm
E
50 µm

pleurogenous, cylindrical to broad subacerose, attenuate at the base, obtuse at the apex, straight, 1-euseptate, hyaline, smooth, 18–23 × 2 µm, accumulating in white, slimy masses, more or less near the conidiophores central part.

Notes: Among the six previously described *Paliphora* species, only *P. intermedia* Alcorn and *P. porosa* Kuthub. are superficially similar to *P. bicolorata* by producing 1-septate conidia, but these species are otherwise clearly distinguished from *P. bicolorata*. In *P. intermedia* (which has been isolated from decaying leaves of several plants in Brazil, Cuba, and Mexico; Gusmão et al. 2008) the conidia are shorter (14.5–19 µm long) with a slightly asymmetrical septum and the conidiophores are uniformly brown (Alcorn 1996; Rao & de Hoog 1986, as "*P. aurea*"). *Paliphora porosa* produces cylindrical to clavate conidia that are usually 1-septate (rarely 2–3-septate) and somewhat constricted at the septa and uniformly golden brown longer (200–280 µm) conidiophores with more septa (15–23-septate; Kuthubutheen 1987).

Key to *Paliphora* species

1. Conidia usually unicellular 2
   Conidia usually septate 3
2. Conidia cylindrical, straight or curved, 17–20 × 1–2 µm; conidiophores cylindrical below, inflated near the apex, verrucose, 13–19-septate, dark brown, 142–20 × 1–2 µm ..... *P. inflata*
   Conidia falcate, obtuse and widest at the apex, attenuating gradually to a narrow base, 6.5–9 × 1–1.5 µm; conidiophores cylindrical, smooth below, acute, verrucose toward the apex, 11–18(–23)-septate, evenly golden brown, 99–132 × 5.5–6.5 µm ..... *P. aurea*
3. Conidia 1-septate 4
   Conidia >1-septate 6
4. Conidiophores bicolored, golden brown below and dark reddish-brown at the four distal cells, ≤17-septate, smooth below, verruculose near the apex, 170–220 × 4–6 µm; conidia cylindrical to broad sub-acerose, obtuse at the apex, attenuated at the base, 18–23 × 2 µm ..... *P. bicolorata*
   Conidiophores not as above 5
5. Conidiophores evenly brown, cylindrical below, acute at the apex, 16–22-septate, smooth below, verrucose near the apex, 135–205 × 6–7 µm; conidia, cylindrical or fusoid, apex obtuse, base subacute or obconic, straight or slightly curved, asymmetrically septate, 14.5–19 × 2 µm ..... *P. intermedia*
   Conidiophores evenly golden brown, cylindrical below, acute at the apex, 15–23-septate, smooth below, verrucose near the apex, 200–280 × 5–9 µm; conidia, cylindrical to clavate, symmetrical, slightly constricted at the septa, apex obtuse, base acute, straight, 12–25 × 1–2.5 µm ..... *P. porosa*

6. Conidia 3–6-septate, elongate-fusiform or narrowly, sometimes slightly sigmoid, 40–70 × 2–3 µm; conidiophores cylindrical, apex rounded, brown, 20–63-septate, smooth, 170–540 ×4.5–5 µm ..... *P. curviapicis*

   Conidia 8–13-septate, cylindrical, apex obtuse, base obconic, straight or slightly curved, 50–65 × 2.5 µm; conidiophores cylindrical below, bulbous at the basal cell, apex acute, brown, ≤16-septate, smooth below, verrucose toward the apex, 85–210 × 6–7.5 µm ..... *P. multiseptata*

Acknowledgments

The authors express their sincere gratitude to Dr. Xiu-Guo Zhang and Dr. De-Wei Li for their critical review of the manuscript. The authors are grateful to Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) for financial support (project 88881.062172/2014-01) and the Programa Ciência sem Fronteiras. RFCR is grateful to the Cuban Ministry of Agriculture and Programa de Salud Animal y Vegetal (project P131LH003033) for facilities. We acknowledge the facilities provided by Dr. P.M. Kirk and Drs. V. Robert through the Index Fungorum and MycoBank websites. Dr. Lorelei Norvell's editorial review and Dr. Shaun Pennycook's nomenclature review are greatly appreciated.

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MYCOTAXON

ISSN (print) 0093-4666 (online) 2154-8889 Mycotaxon, Ltd. ©2017

October–December 2017—Volume 132, pp. 909–918

https://doi.org/10.5248/132.909

Inocybe shawarensis sp. nov. in the Inosperma clade from Pakistan

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Abstract —A new species, *Inocybe shawarensis*, was collected during field research on ectomycorrhizal fungi associated with oak forests in Swat district, Pakistan. This species, supported by a combination of morphological and molecular phylogenetic analyses, is characterized by a brown, fibrillose campanulate pileus, grayish lamellae, slightly bulbous stipe base, slightly pruinose silvery white stipe, small phaseoliform spores, and clavate cheilocystidia. We present phylogenetic analyses based on DNA sequences from the internal transcribed spacer (ITS) region and large subunit (LSU) of the nuclear ribosomal RNA (rRNA). Phylogenies from both DNA regions cluster *I. shawarensis* within the Maculata subclade in the Inosperma clade.

Key words — *Agaricomycetes*, *Inocybaceae*, *Quercus*, Shawar Valley

Introduction

The *Inocybaceae* is one of the most taxonomically diverse families of *Agaricales*. Its representatives form ectomycorrhizal (EcM) associations with many angiosperms and gymnosperms in tropical and temperate areas. Between 70% and 80% of species in the family have been described in association primarily with ectomycorrhizal plant families *Fagaceae*, *Pinaceae* and *Salicaceae* (Kirk et al. 2008).

Inocybe (Fr.) Fr., one of three formally described genera in *Inocybaceae,* was first established by Fries as a "tribe" of *Agaricus* in 1821 and later elevated to genus rank in 1863 (Matheny et al. 2009). The genus has been divided into

subgenera and sections based on spore morphology, shape and distribution of cystidia on fruit body tissues, and stipe morphology. Multigene phylogenetic analysis by Matheny (2009) identified seven clades within *Inocybaceae*: Auritella, Inocybe, Inosperma, Mallocybe, Mallocybella, Nothocybe, and Pseudosperma.

The Inosperma clade is characterized phylogenetically as a robustly supported monophyletic group including species with radially fibrillose to rimose or squamulose pilei and ellipsoid to phaseoliform spores but lacking metuloid pleurocystidia. Many species of the Inosperma clade also feature unusual odors, and some may have rubescent or brunnescent flesh.

Among the more than 850 *Inocybe* species reported worldwide (Matheny et al. 2009, 2012; Kobayashi & Onishi 2010, Horak et al. 2015, Jabeen et al. 2016), at least 47 *Inocybe* species are resolved in the Inosperma clade (Matheny 2009, Matheny et al. 2009, Kropp et al. 2013, Pradeep et al. 2016, Latha & Manimohan 2016). From Pakistan, 26 species of *Inocybe* have been reported, but only a few studies have verified the taxonomic identity of specimens using molecular data (Ahmad et al. 1997, Ilyas et al. 2013, Saba et al. 2015, Jabeen et al. 2016). The only species in the Inosperma clade that has been reported from Pakistan is *Inocybe mimica* Massee (Saba et al. 2015).

Here we describe a new species, *Inocybe shawarensis*, from Shawar Valley, Swat district, Pakistan. The specimens were characterised by morphological characters as well as molecular datasets based on the internal transcribed spacer (ITS) and large subunit (LSU) of nrDNA. Based on traditional classifications (Kühner 1980, Kuyper 1986, Stangl 1989), our new species would be placed in *Inocybe* sect. *Rimosae* within *I.* subg. *Inosperma*.

Materials & methods

Sampling Site

The Swat district (34.34–35.55°N 72.08–72.50°E), situated in the Khyber Pakhtunkhwa Province of Pakistan, is well known for its unique biodiversity (Shinwari et al. 2003). Its Shawar Valley, which occupies an area of 48.77 km^2 within the Hindu Kush mountain range (Ahmad & Sirajuddin 1996), is topographically mountainous, varying in elevation from 1200 m to 3800 m (Anonymous 1999). Floristically the Valley is representative of the western Himalayan Province. The climate is moist temperate with temperatures averaging a winter minimum of 4.8°C and summer maximum of 33.5°C and an average annual rainfall of about 800 mm, with precipitation occurring in spring and summer seasons with snowfall at higher elevations (Ullah et al. 2014).

Fruiting bodies of *Inocybe,* collected during a field investigation of ectomycorrhizal communities associated with the oaks of Swat during 2014-2016, were found in a pure *Quercus* forest in Shawar Valley. The type locality lies in a thick moist temperate forest

of *Quercus oblongata* D. Don [= *Q. incana* Roxb., nom. illeg.] along a tributary of the Swat River.

Morphological analyses

Fruiting bodies of *Inocybe* were collected and photographed in the field using a Nikon D70S camera. Morphological characters were recorded from fresh specimens. Color designations were based on the Munsell Color System (Munsell 1975). For preservation specimens were dried using an electric fan heater. Rehydrated material was examined microscopically in 5% KOH, phloxine, and Melzer's reagents.

Anatomical features of basidiospores, basidia, cystidia, stipe hyphae and pileus hyphae were measured at 1000× magnification and include: arithmetic mean of spore length and width for all spores measured, Q = spore length divided by spore width. Spore size range was determined by 30 basidiospore measurements from each fruiting body.

Specimens were deposited in the Herbarium, Department of Botany, University of the Punjab, Lahore, Pakistan (LAH) and the University of Florida Herbarium, Gainesville FL, USA (FLAS).

DNA extraction, amplification and sequencing

Genomic DNA was extracted from gill tissue using a modified CTAB method (Gardes & Bruns 1993). ITS and LSU regions were amplified by the primer pairs ITS1F/ITS4B and LR0R/LR5, respectively. All PCR products were evaluated for successful amplification using SYBR Green and 1.5% agarose gels with TAE buffer for gel electrophoresis. Amplicons were prepared for sequencing via enzymatic purification using Exonuclease I and Shrimp Alkaline Phosphatase enzymes (Werle et al. 1994). Purified products were sequenced by the University of Florida's Interdisciplinary Center for Biotechnology Research (http://www.biotech.ufl.edu/). Sequence chromatograms were trimmed, edited, and assembled using Sequencer 4.1 (GeneCodes, Ann Arbor, MI). DNA sequences generated for this study were deposited in GenBank.

Molecular phylogenetic analysis

For alignment and phylogenetic analysis, the top 100 BLAST search result sequences were selected from GenBank using NCBI BLAST (http://www.ncbi.nlm.niih.gov/). Other closely related species were also included based on the published literature in the final dataset. Sequences were manually edited and assembled using BioEdit (www.mbio.ncsu.edu/bioedit/bioedit.html). After sequence alignment by Muscle, all sequences were trimmed between the conserved motifs 5′–(...GAT) CATTA– and –GACCT(CAAA...)–3′ (Dentinger et al. 2011). *Auritella* species were selected as outgroup based on results reported by Larsson et al. (2009). Phylogenetic trees were constructed with the Maximum Likelihood (ML) algorithm using a general time-reversible model (Nei & Kumar 2000) and nearest-neighbour interchange as the ML heuristic search method using MEGA6 software. The topology was assessed by 1000 bootstrap replicates.

Initial tree(s) for the heuristic search were obtained by applying the Neighbor-Joining method to a matrix of pairwise distances estimated using the Maximum

Composite Likelihood (MCL) approach. The tree is drawn to scale, with branch lengths measured in the number of substitutions per site. Evolutionary analyses were conducted in MEGA6 (Tamura et al. 2013).

Taxonomy

Inocybe shawarensis Naseer & Khalid, **sp. nov.** Fig. 1

MycoBank MB 820130

Differs from *Inocybe quietiodor* by its brown pileus with a less prominent, campanulate umbo, its gray gills, its silvery lower stipe and dark gray upper stipe, and its smaller, more phaseoliform spores.

Type: Pakistan, Khyber Pakhtunkhwa province, Swat district, Shawar Valley, 2100 m a.s.l, solitary on ground under *Quercus oblongata* D. Don [= *Q. incana* Roxb., nom. illeg.], 14 July 2015, Arooj Naseer ASSW79 (Holotype, FLAS-F-S9456; GenBank KY616964, KY616966. Isotype, LAH35195; GenBank KY616965).

Etymology: The specific epithet *shawarensis* refers to the Shawar Valley, the location where the type was collected.

Pileus: 30 mm diam., campanulate, umbonate, margin slightly incurved or deflexed; surface fibrillose, rimose or cracked towards the margin; dark brown (7.5YR4/8) at the centre, becoming lighter brown in patches towards the margin that is creamy white (10Y8/2). Lamellae subdistant, fimbriate, eroded, light gray (2.5GY8/2) when young; Lamellulae of varying lengths, alternating with lamellae. Stipe: 4.8 × 0.4 cm, cylindrical, central; surface fibrillose, apex slightly pruinose, slightly narrower towards apex, base slightly swollen to bulbous; base light brown (7.5YR4/8) with lower two third creamy or silvery white and upper one third dark gray (2.5YG5/2)

Basidiospores [60/2/1], (4.5–)4.7–6.5(–6.8) × (2.7–)2.8 × 3.7(–3.8) µm, avl × avw = 5.2 × 3.2 µm, Q = (1.2–)1.3–1.9(–2.5), avQ = 1.63, yellowish brown in KOH, smooth, thick walled, phaseoliform. Basidia 22–31 × 6–10 µm, light brown, clavate, blunt ended, four–spored. Cheilocystidia 21–55 × 9–11 µm, clavate, thin walled, in groups. Pleurocystidia none. Pileipellis a radially orientated cutis of thin-walled hyphae, 5–7 µm diam., cylindrical, walls smooth or finely encrusted, light brown in KOH, blunt ends, septate, clamped. Caulocystidia only at apex, more or less similar to cheilocystidia. Stipitipellis hyphae 4–7 µm diam., septate, filamentous, unbranched. Clamp connections present. Odour not recorded.

Molecular phylogenetic analysis

Inocybe shawarensis sequences of the amplified products of ITS (KY616964, KY616965) and LSU (KY616966) were BLAST searched at NCBI. Both the ITS and

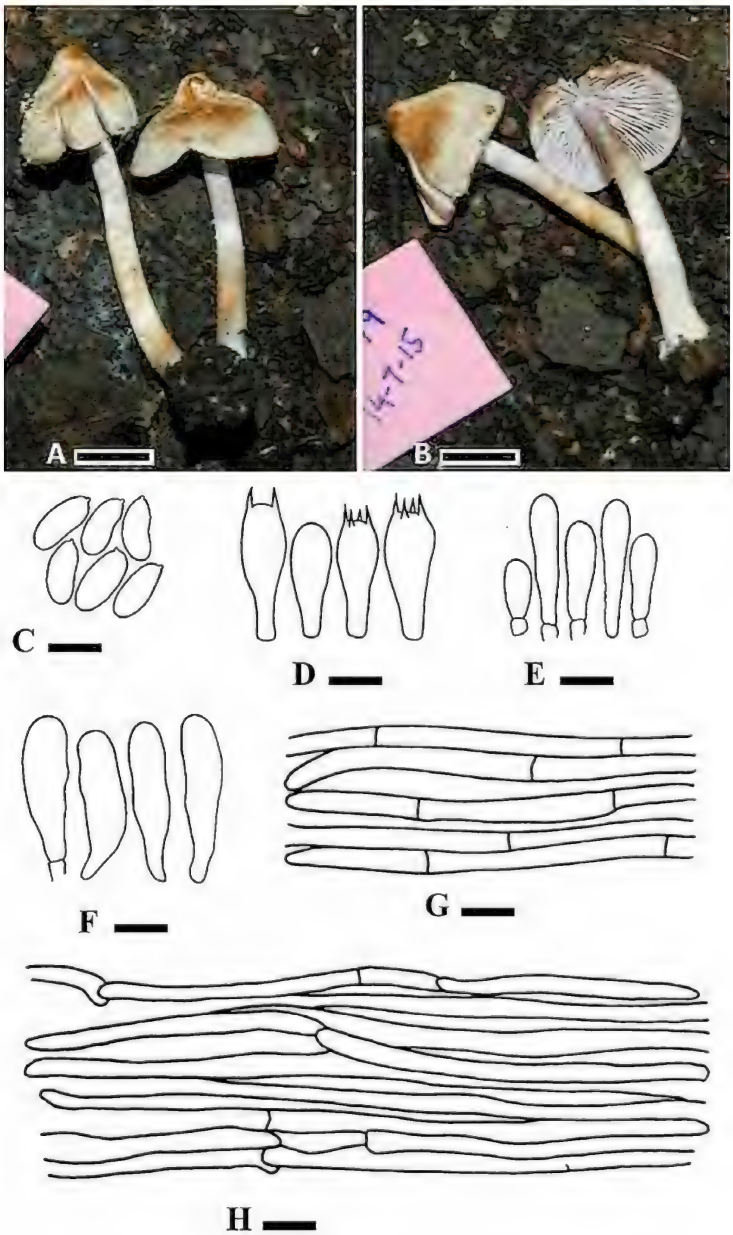

Fig. 1. *Inocybe shawarensis* (isotype, LAH35195). A, B. basidiomata; C. basidiospores; D. basidia; E. cheilocystidia; F. caulocystidia; G. pileipellis; H. stipitipellis. Scale bars: A, B = 1.5 μm; C = 5 μm; D = 12 μm; E, F = 16 μm; G, H = 13 μm.

LSU sequences suggest a close affinity with *I. quietiodor* Bon. The LSU sequence was 97% identical to *I. quietiodor* (FJ904174) with 100% query coverage, whereas the ITS sequence showed 93% sequence similarity with *I. quietiodor* (FJ936168) with 100% query coverage. The ITS analysis comprised 52 nucleotide sequences with 1405 positions total in the final dataset, while the LSU analysis comprised 40 nucleotide sequences with 852 positions in the final dataset.

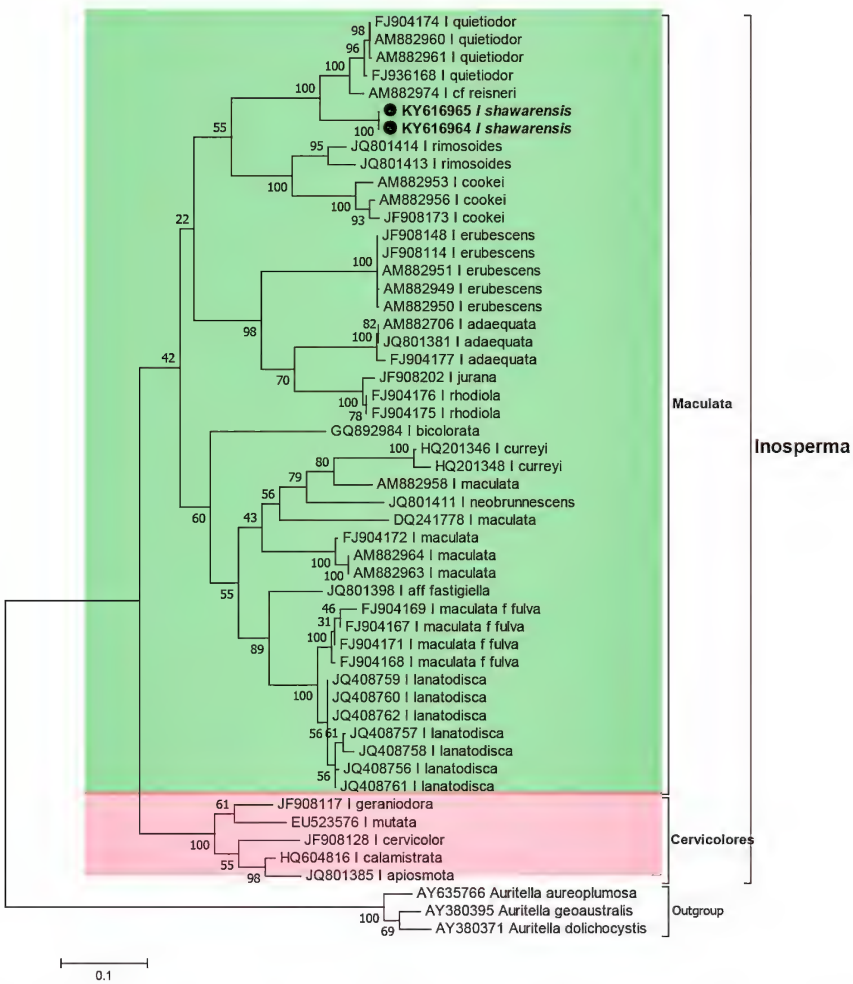

FIG. 2. Molecular phylogenetic analysis of ITS sequences from *Inocybe* spp. in the Inosperma clade inferred by using the Maximum Likelihood method. The analysis involved 52 nucleotide sequences. The tree with the highest log likelihood (–9223.6738) is shown. Sequences generated during this study are represented by dots.

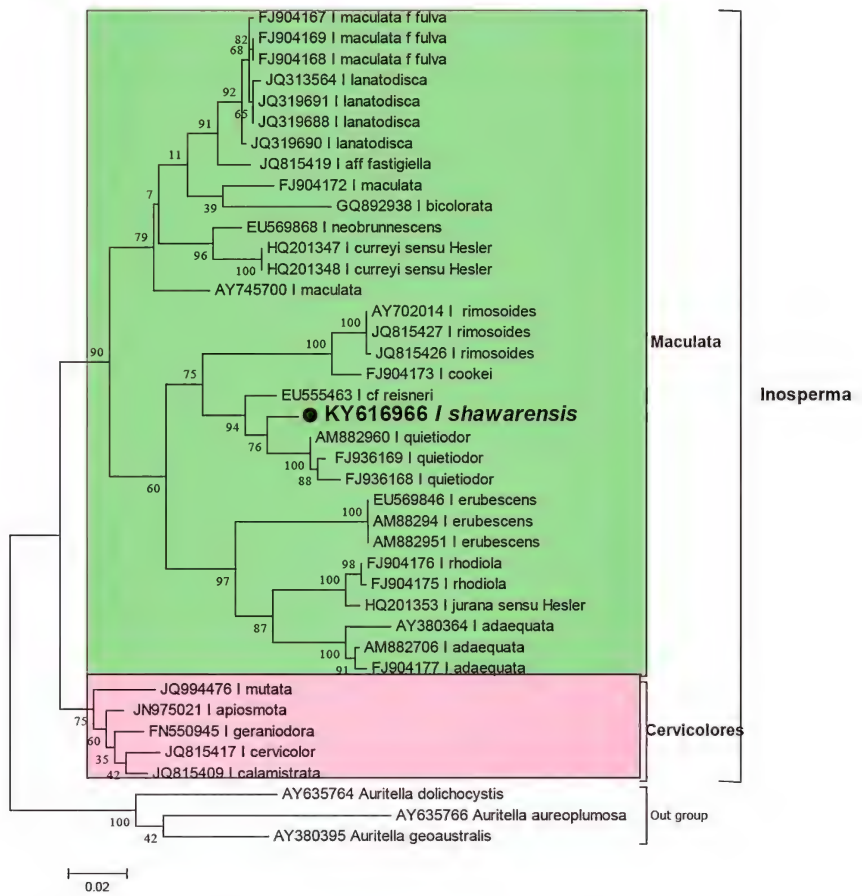

FIG. 3. Molecular phylogenetic analysis of LSU sequences from *Inocybe* spp. in Inosperma clade inferred by using the Maximum Likelihood method. The analysis involved 40 nucleotide sequences. The tree with the highest log likelihood is shown. The sequence generated during this study is represented by a dot.

Our analysis revealed two major lineages within the Inosperma clade. The new species clustered with *I. quietiodor* in the Maculata subclade, whereas the Cervicolores subclade was resolved as a distinctly monophyletic group.

The percentage of trees in which the associated taxa clustered together is shown next to the branches.

Discussion

Species in the Maculata subclade are characterized in part by the presence of thin-walled often clavate to pyriform cheilocystidia, phaseoliform spores, and specific odours, and the stipe base tends to be distinctly bulbous, as found in *I. cookei* Bres., *I. maculata* Boud., and *I. quietiodor* (Larsson et al. 2009).

Inocybe shawarensis is characterized by its brown fibrillose campanulate pileus, grayish hymenium, a stipe surface that is silvery white on the lower two-thirds and dark gray on the upper third, a cylindrical stipe that is slightly pruinose at apex, slightly bulbous stipe base, an absence of pleurocystidia, and small phaseoliform yellowish brown spores. Our new species is morphologically similar to *Inocybe quietiodor* but separated with 70% bootstrap value from *I. quietiodor* (FJ93618, AM882950, AM882961), with which it forms a sister clade that includes *Inocybe* cf. *reisneri* (sampled from Japan).

Compared to *I. shawarensis,* characterized with a brown campanulate pileus and gray gills, *I. quietiodor* has a more prominently umbonate yellowish (5Y8/10) pileus and yellowish lamellae. *Inocybe quietiodor* is further distinguished by its yellow cylindrical stipe with the whitish bulbous base and larger and less phaseoliform spores. *Inocybe cookei* is distinguished morphologically by its conspicuously marginate bulbous base (bulb ≤16 mm) and pyriform cheilocystidia.

The Indian species *I. gregaria* K.P.D. Latha & Manim., *I. virosa* C.K. Pradeep et al., and *I. carnosibulbosa* C.K. Pradeep & Matheny falling in the Inosperma clade "Old World tropical clade 2" may be comparable to our taxon. *Inocybe shawarensis* differs from these, however, by its placement in the Maculata subclade and its smaller basidiomata (Pradeep et al. 2016, Latha & Manimohan 2016).

Acknowledgements

We are sincerely grateful to Dr. Brandon Matheny, Department of Ecology and Evolutionary Biology, University of Tennessee, Knoxville, USA, for his comments on an earlier version of this paper. We wish to express our gratitude to Dr. Abdul Rehman Niazi (Assistant Professor, Department of Botany, University Of the Punjab, Lahore) for also acting as pre-submission reviewer of this manuscript. We are also thankful to Dr. Sana Jabeen (University of Education, Lahore) for her help during the manuscript preparation.

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MYCOTAXON

ISSN (print) 0093-4666 (online) 2154-8889 Mycotaxon, Ltd. ©2017

October–December 2017—Volume 132, pp. 919–923

https://doi.org/10.5248/132.919

Phaeomonilia aquatica sp. nov., an aquatic hyphomycete from China

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Abstract—A new aquatic hyphomycete, *Phaeomonilia aquatica*, is described and illustrated from specimens collected on submerged wood in Jiangxi Province, China. *Phaeomonilia aquatica* is morphologically characterized by conidiophores with percurrent proliferation and aseptate smooth conidia that are spherical, subtriangular, subglobose, ellipsoidal to subfusiform or obovate and formed in branched acropetal chains. A key to *Phaeomonilia* species is provided.

Key words — anamorphic fungi, freshwater fungi, lignicolous fungi, taxonomy

Introduction

Hyphomycetous fungi are highly diverse in freshwater habitats (Hu et al. 2013). As essential components in aquatic ecosystems, they play an irreplaceable role in the natural cycle of organic materials and energy. Their global distribution is poorly studied (Shearer et al. 2007), but our group has investigated the distribution of aquatic hyphomycetes for about ten years (Hu et al. 2007, 2010a,b, 2012a,b,c, 2013; Huang et al. 2016). The ongoing investigation in Jiangxi Province, China, has led to the collection of a new species of *Phaeomonilia* R.F. Castañeda et al.

Materials & methods

Unidentified wood samples submerged in a freshwater stream were collected in Jiangxi Province, China, and incubated in moist chambers at room temperature (ca. 25

°C). Samples were examined for fungal fruiting bodies using a dissecting microscope. Observations and photographs were prepared from materials mounted in water and examined with a Nikon Ni compound microscope (Hu et al. 2012a). The specimens examined were deposited in the Herbarium of Fungi, Jiangxi Agricultural University, Nanchang, China (HFJAU).

Taxonomy

Phaeomonilia aquatica J.E. Huang, H.Y. Song, Jian Ma & D.M. Hu, **sp. nov.** Pl1

MycoBank MB 821142

Differs from *Phaeomonilia guangxiensis* by its conidiophores with percurrent proliferations through the apex and by its narrower conidia, and from *P. nanningensis* by its conidiophores with percurrent proliferations through the apex and by its shorter hyaline to yellowish conidia.

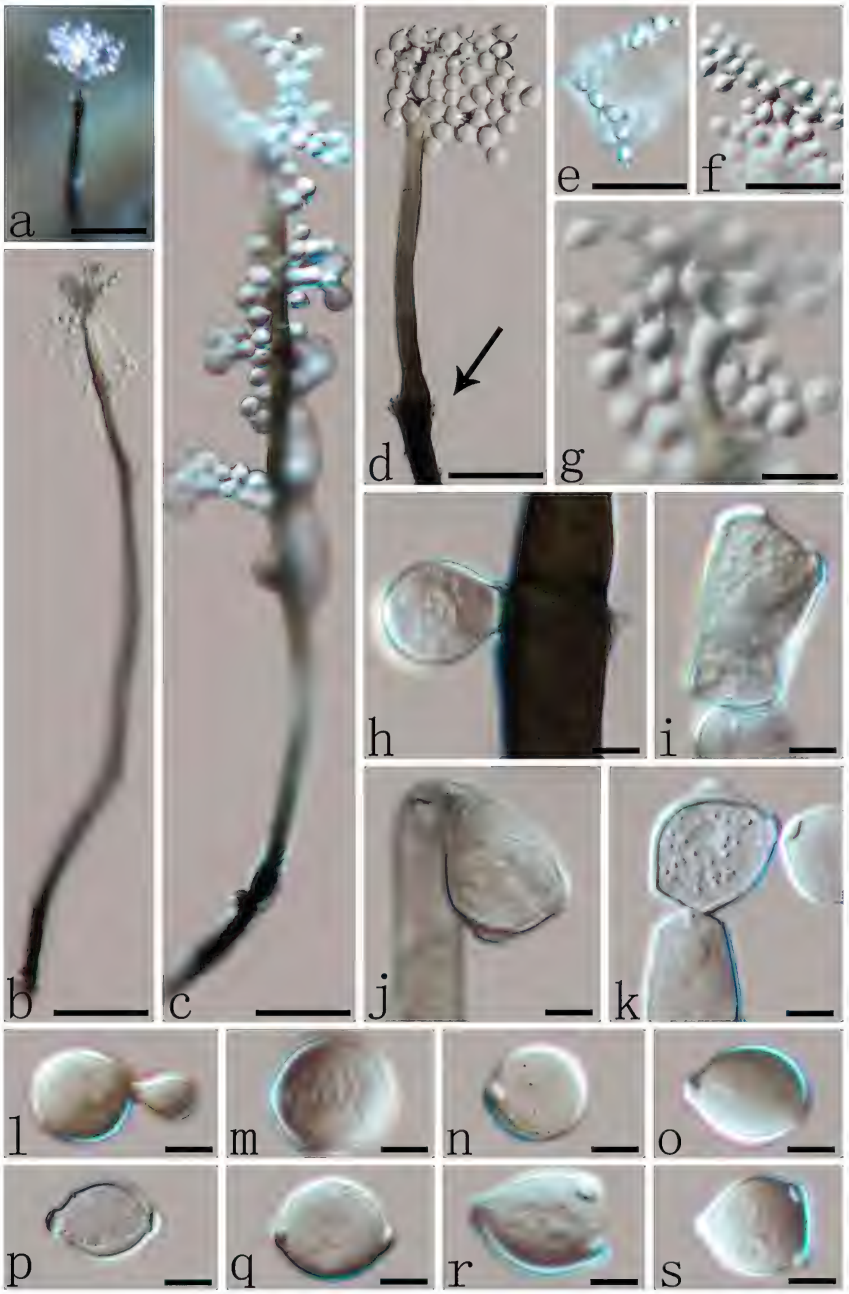
Type—China, Jiangxi Province, Jiujiang, Lushan Mountain, in a stream on submerged wood, 13 Oct. 2016, J.E. Huang (**Holotype**, HFJAU 0148).

Etymology—*aquatica*, referring to the aquatic habitat of the fungus.

Colonies on submerged wood effuse, brown to dark brown, consisting of scattered single conidiophores over the substrate surface. Mycelium immersed or superficial, composed of brown, cylindrical, septate, infrequently branched hyphae. Conidiophores macronematous, mononematous, sometimes more than 900 µm long and 8.5–18 µm diam., single, erect, straight or flexuous, branched or unbranched, smooth, occasionally rough, 15–35-septate, thin-walled, brown to dark brown toward the base, fading slightly toward the apex, with percurrent proliferations through the apex, giving rise to new conidiogenous loci at the apex. Conidiogenous cells holothallic, 12–29 × 8.5–13 µm, terminal, subapical or lateral, obovoid, cupulate or obtrapezoid, smooth, pale brown, with several pale brown to hyaline trapezoid denticles, 3.0–5.9 × 0.9–2.3 µm. Conidia thallic-arthric, 1-celled, 8–14 × 7.5–12 µm, spherical, subtriangular, subglobose, ellipsoidal to subfusiform or obovate, hyaline to yellowish, in branched acropetal chains of about seven conidia, thin-walled, with some small wart on the surface. Conidial secession schizolytic.

Additional specimen examined—**China**, **Jiangxi Province**, Jiujiang, Lushan Mountain, in a stream on submerged wood, 13 Oct. 2016, J.-E. Huang (HFJAU 0323).

Plate 1. *Phaeomonilia aquatica* (holotype, HFJAU 0148). a. Conidiophore and conidia on submerged wood; b–d. Conidiophores and conidia. Note the proliferation (arrowed in d); e–f. Conidial chains; g. Conidiogenous cell with conidia; h–k. Conidiogenous cells; l–s. Conidia. Scale bars: a, b = 100 µm; c–f = 50 µm; g = 20 µm; h–s = 5 µm.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Discussion

Castañeda-Ruíz et al. (2007) erected *Phaeomonilia* for two species, *P. pleiomorpha* R.F. Castañeda et al. (type species) and *P. corticola* (R.F. Castañeda) R.F. Castañeda et al. [≡ *Monilia corticola* R.F. Castañeda]. They compared *Phaeomonilia* morphologically with similar genera, including *Botryomonilia* Goos & Piroz., *Staheliella* Emden, and *Oidiodendron* Robak. Subsequently, Ma et al. (2015) and Yang et al. (2016) described *P. guangxiensis* Y.R. Ma & X.G. Zhang and *P. nanningensis* C.L. Yang & X.G. Zhang from China. *Phaeomonilia pleiomorpha* was collected from a palm petiole submerged in a stream, but the other three species were collected from decaying petioles, twigs, or stems in terrestrial habitats. *Phaeomonilia aquatica* is the second species reported from freshwater habitats.

Phaeomonilia aquatica can be easily distinguished from the other species of *Phaeomonilia* by its percurrently proliferating conidiophores. In addition, *P. pleiomorpha* differs from *P. aquatica* by its smaller, globose, broadly Y-shaped conidia (4.0–5.8 × 3.9–4.4 µm) and its *Stylaspergillus*-like synanamorph (Castañeda-Ruíz et al. 2007); *P. guangxiensis* differs by its slightly shorter and wider, colorless, ellipsoid to globose, broadly Y-shaped conidia (7–11 × 11–14.5 µm; Ma et al. 2015); *P. nanningensis* differs by its longer and slightly wider, brown to pale brown conidia (13.5–25 × 9–13 µm; Yang et al. 2016); and *P. corticola* differs by its narrower, doliiform or ellipsoid conidia (5.5–16 × 4–5 µm; Castañeda-Ruíz et al. 2007). A key to *Phaeomonilia* species is presented below.

Key to species of *Phaeomonilia*

1. *Stylaspergillus*-like synanamorph present ..... *P. pleiomorpha*
1. No *Stylaspergillus*-like synanamorph 2
2. Conidia doliiform or ellipsoid, 5.5–16 × 4–5 µm ..... *P. corticola*
2. Conidia not doliiform, >7.5 µm diam. 3
3. Conidiophores with percurrent proliferation; conidia spherical, subtriangular, subglobose, ellipsoidal to subfusiform, or obovate..... *P. aquatica*
3. Conidiophores without percurrent proliferation; conidia ellipsoidal, globose, or Y-shaped 4
4. Conidia hyaline, 7–11 × 11–14.5 µm .....*P. guangxiensis*
4. Conidia brown to pale brown, 13.5–25 × 9–13 µm .....*P. nanningensis*

Acknowledgments

The authors express their sincere gratitude to Dr. Eric H.C. McKenzie and Dr. Huang Zhang for their critical review of the manuscript, to Dr. Shaun Pennycook for

nomenclatural review, and to Dr. Lorelei L. Norvell for editorial review. This project was supported by the National Natural Science Foundation of China (Nos. 31500021, 31460009) and The Key Research and Development Program of Jiangxi Province (No. 20161BBF60078).

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MYCOTAXON

ISSN (print) 0093-4666 (online) 2154-8889 Mycotaxon, Ltd. ©2017

October–December 2017—Volume 132, pp. 925–931

https://doi.org/10.5248/132.925

Minimelanolocus atlanticus sp. nov. and *M. navicularis* from the Brazilian Atlantic Forest

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Abstract—*Minimelanolocus navicularis* and a new species, *M. atlanticus*, are described and illustrated from collections on decaying leaves of unidentified plants. *Minimelanolocus atlanticus* is distinguished by oblong, 2-septate conidia, with brown basal and central cells and gray to subhyaline apical cell and slightly flattened or sub-rounded apex. Notes are provided on *M. navicularis* recorded from Brazilian Atlantic Forest.

Key words—conidial fungi, asexual fungi, neotropic, systematic

Introduction

The genus *Minimelanolocus*, established by Castañeda-Ruiz et al. (2001) and typified by *Pseudospiropes navicularis* R.F. Castañeda [≡ *M. navicularis*], is characterized by conidiophores that are macronematous, mononematous, erect, unbranched, smooth or verrucose and conidiogenous cells that are polyblastic, sympodial elongated, terminal, indeterminate, and with inconspicuous or slightly prominent, narrow, opaque, refractive to somewhat obscure conidiogenous loci. *Minimelanolocus* currently comprises 31 species (Castañeda-Ruiz et al. 2001, 2003; Fiuza et al. 2017; Heredia et al. 2014; Hernández-Restrepo et al. 2012; Liu et al. 2015; Ma et al. 2008, 2011; Tian

et al. 2016; Xia et al. 2014; Zhang et al. 2009, 2010), most of which occur as saprobes on decaying leaves, rotten wood, dead branches, bamboo culms, and submerged plant debris in aquatic habitats.

During a mycological survey of microfungi associated with leaf litter in a Brazilian Atlantic forest, two conspicuous fungi representing *Minimelanolocus* were collected. We describe one as a new species and present a new description of the other, *M. navicularis*.

Materials & methods

Individual collections were placed in plastic bags, taken to the laboratory, and treated according to Castañeda-Ruiz et al. (2016). Mounts were prepared in lactic acid (90%) or in polyvinyl alcohol-glycerol (8 g PVA in 100 ml H_2O + 5 ml glycerol) and lactofuchsin (0.1 g acid fuchsin in 100 ml 85% lactic acid) following Carmichael (1955). Measurements were made at a magnification of ×1000 under a Nikon Eclipse Ni-U microscope with bright field optics, and photomicrographs were taken using DIC optics with a Nikon DS-Fi2 camera. The holotype was deposited in the Herbarium of Universidade Federal de Pernambuco, Recife, Brazil (URM).

Taxonomy

Minimelanolocus atlanticus P.M.O. Costa, Malosso & R.F. Castañeda, **sp. nov.** Figs 1, 2

Index Fungorum IF 554056

Differs from *Minimelanolocus obscurus* by its 2-septate and versicolored conidia.

Type: Brazil, Pernambuco, Igarassú, RPPN Refúgio Ecológico Charles Darwin, 7°48′S 34°57′W, on decaying leaves of an unidentified plant, 12.V.2017, coll. P.M.O. Costa (**Holotype**, URM 90133).

Etymology: Latin, *atlanticus*, refers to habitat of the fungus, Brazilian Atlantic Forest.

Colonies on the natural substrate, effuse, hairy, brown. Mycelium superficial and immersed, composed of septate, branched, brown, smooth-walled hyphae, 2–3 µm diam. Conidiophores macronematous, mononematous, erect, straight or flexuous, cylindrical, slightly geniculate near the apex, unbranched, 7–15-septate, dark brown below, pale brown toward the apex, 200–300 × 5–7 µm, smooth. Conidiogenous cells polyblastic, somewhat sinuate with inconspicuous denticulate or faintly cicatrized, opaque loci, terminal, integrated, indeterminate with several sympodial extensions, pale brown, 30–60 × 3.5–4 µm. Conidial secession schizolytic. Conidia solitary, acropleurogenous, oblong, sub-rounded or slightly flattened at the apex, 2-septate, bicolor with basal and central cells brown to dirty brown, apical cell smoked-gray to subhyaline, smooth, dry, 18–21 × 4–5 µm. Sexual state unknown.

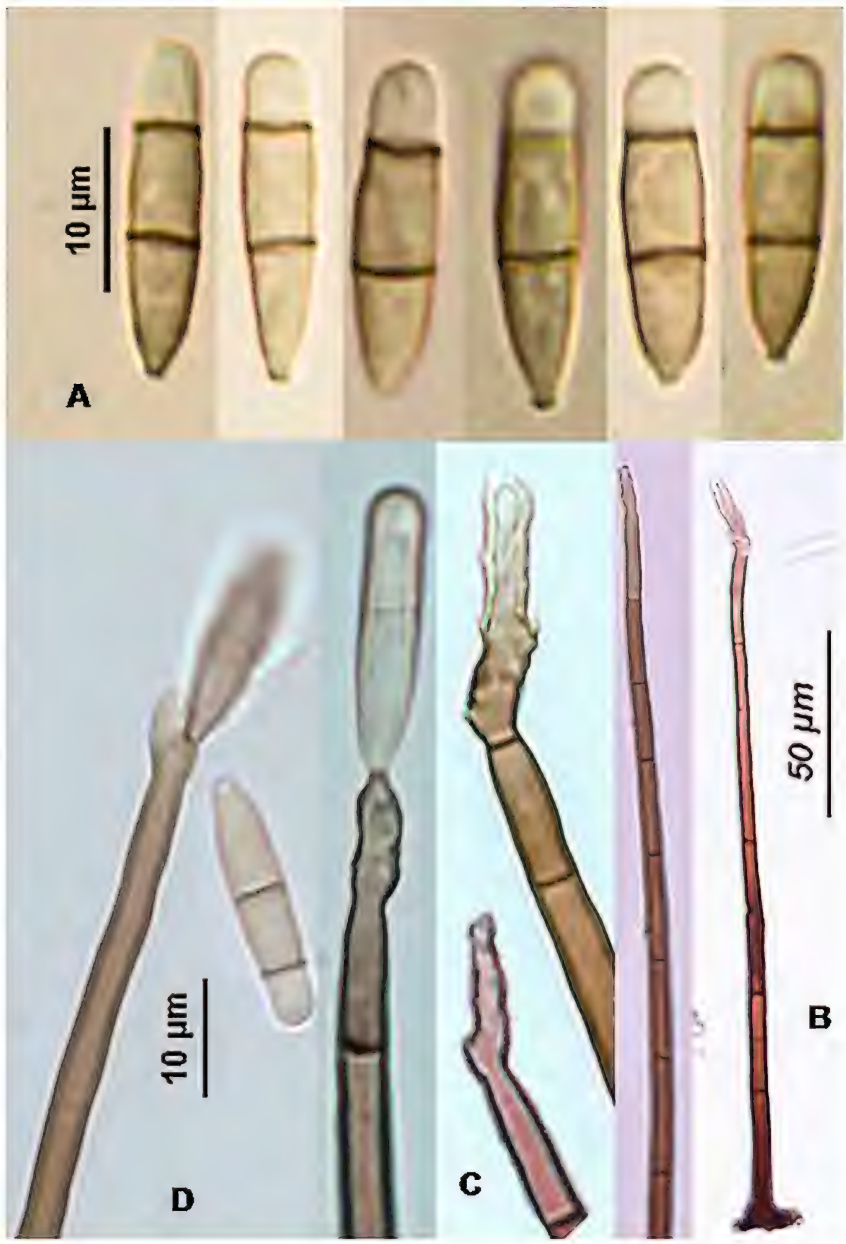

Fig. 1. *Minimelanolocus atlanticus* (ex holotype URM 90133). A. Conidia; B. Conidiophores and conidiogenous cells; C. Conidiogenous cells; D. Conidiogenous cells and conidia. C & D share the same scale.

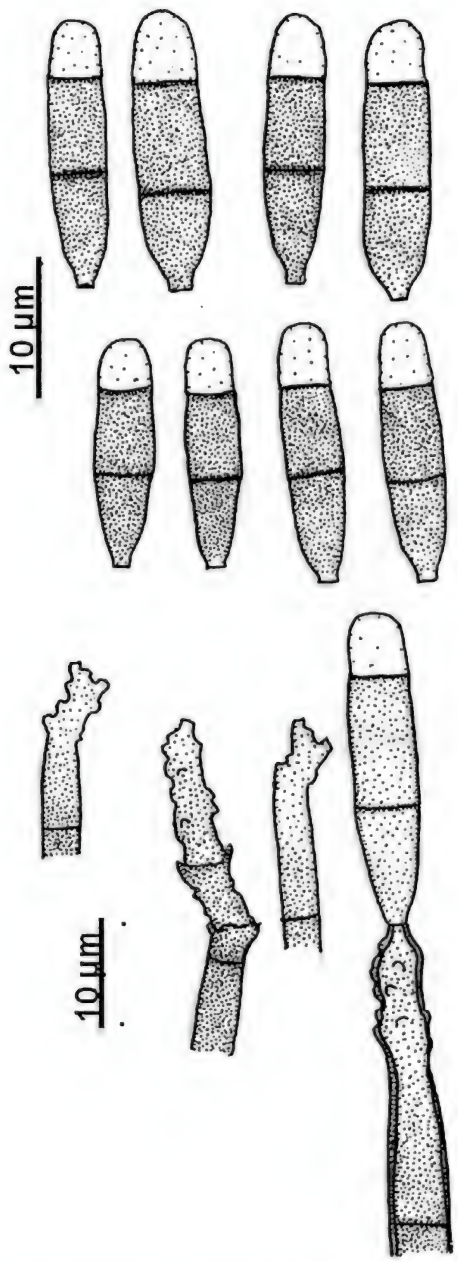

Fig. 2. *Minimelanolocus atlanticus* (ex holotype URM 90133). Conidiogenous cells and conidia.

Notes: *Minimelanolocus obscurus* (Matsush.) R.F. Castañeda & Heredia [≡ *Pseudospiropes obscurus* Matsush.] is similar to *M. atlanticus* in producing oblong conidia but is distinguished by conidia that are 1–4-septate (usually 3-septate), larger (18–34 × 4.5–8 µm), and uniformly colored subhyaline or pale brown (Castañeda-Ruiz et al. 2001, Liu et al. 2015, Matsushima 1983).

Minimelanolocus navicularis (R.F. Castañeda) R.F. Castañeda, Cryptog. Mycol. 22: 9 (2001). Fig. 3

Conidiophores macronematous, mononematous, erect, straight or flexuous, unbranched, cylindrical, inflated at the base, 2–5-septate, smooth, brown, pale brown above, smooth, 43–70 × 4–6 µm. Conidiogenous cells polyblastic, integrated, terminal, indeterminate, sympodial elongated,

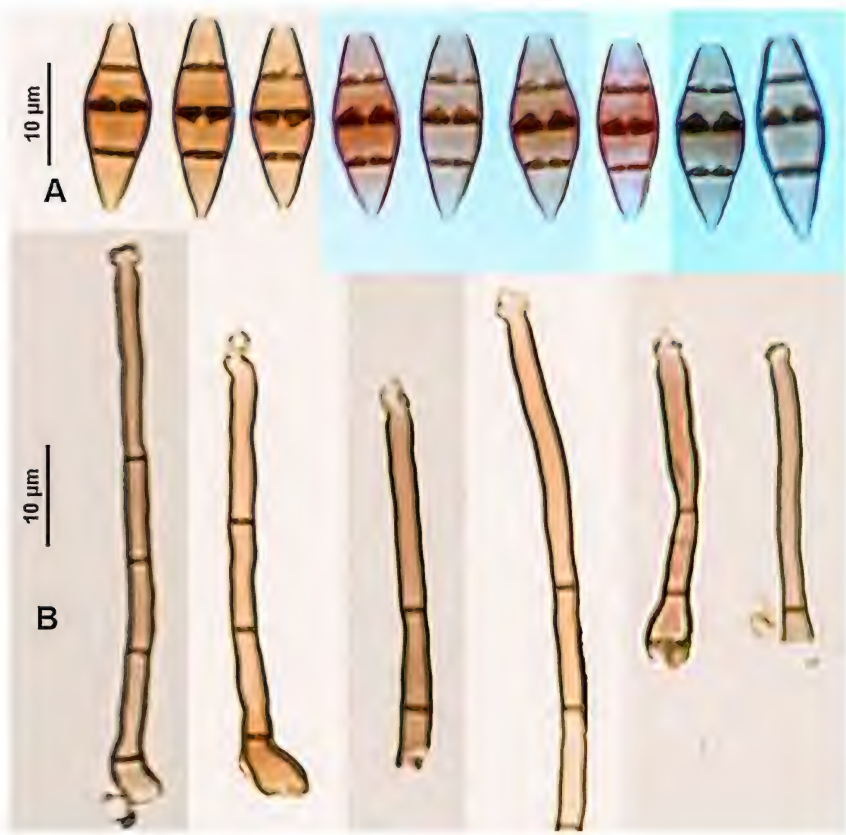

Fig. 3. *Minimelanolocus navicularis* (ex URM 90185).
A. Conidia; B. Conidiophores and conidiogenous cells.

inconspicuous denticulate, slightly melanized at the loci, 14–22 × 3–4 µm, pale brown. Conidial secession schizolytic. Conidia solitary, acropleurogenous, navicular, straight, smooth, 3-euseptate, 17–24 × 5–8.5 µm, obscure at the septa, dry, with subhyaline to pale brown end cells, brown to dark brown central cells.

Specimen Examined: **BRAZIL, Pernambuco State**, Lagoa da Mata, Ilha de Itamaracá, 7°46′S 34°51′W, on decaying leaves of an unidentified plant, 23.XI.2016, coll. W.L. Tavares (URM 90185).

Notes: *Minimelanolocus navicularis* has been previously recorded in Brazil by Santa Izabel et al. (2011); their specimen had longer conidiophores (45–155 µm) than our specimen, but the conidia in both specimens closely match those of the type species (20–25 × 6–8 µm; Castañeda-Ruiz 1987).

Acknowledgments

The authors express their sincere gratitude to Dr. Xiu-Guo Zhang and Dr. De-Wei Li for their critical review of the manuscript. The authors are grateful to the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) (Project 88881.062172/2014-01) and Programa Ciência sem Fronteiras for financial support. RFCR is grateful to the Cuban Ministry of Agriculture and Programa de Salud Animal y Vegetal (Project P131LH003033) for facilities. We acknowledge the facilities provided by Dr. P.M. Kirk and Drs. V. Robert and K. Bensch, through the Index Fungorum and MycoBank websites. Dr. Lorelei Norvell's editorial review and Dr. Shaun Pennycook's nomenclature review are greatly appreciated.

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MYCOTAXON

ISSN (print) 0093-4666 (online) 2154-8889 Mycotaxon, Ltd. ©2017

October–December 2017—Volume 132, pp. 933–941

https://doi.org/10.5248/132.933

New records of *Amanita* from Tehuacán-Cuicatlán Biosphere Reserve, México

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Abstract—Specimens of *Amanita caesarea*, *A. flavoconia*, *A. flavorubescens*, *A. fulva*, *A. onusta*, *A. pantherina*, *A. rubescens*, *A. vaginata*, and *A. verna* are described as new records from Tehuacán-Cuicatlán Biosphere Reserve. There were no records of mycetism produced by the consumption of those species in the reserve.

Key words—*Amanitaceae*, *Agaricales*, edible, Oaxaca, taxonomy, toxic

Introduction

Ruiz-Oronoz & Herrera (1948) and Herrera (1950) were to first to initiate mycological research in the Cuicatlán district of Oaxaca. In 1998, President Ernesto Zedillo Ponce de León proclaimed the studied region as the Natural Protected Area of Tehuacán-Cuicatlán Biosphere Reserve in the states of Puebla and Oaxaca, México, with the intent of conserving its plant, animal, and fungal diversity as well as its huge human cultural wealth. Since mycological studies were restarted in 1996, fungi have been collected in different the vegetation types of tropical subdeciduous forest, deciduous forest, and pine-oak forest. As a result of collaborative work amongst the Institute of Biology (National Autonomous University of Mexico), Ejidal and Communal Commission of Tehuacán-Cuicatlán, and National Commission of Natural Protected Areas with the communities of San Pedro Jocotipac and Santa María Pápalo, nine species of *Amanita* (*Agaricales, Amanitaceae*) have been recorded from this region for the first time.

The aim of this research was to extend the taxonomic knowledge of *Amanita* as an exploitable natural resource. Of the nine *Amanita* spp. identified, four were edible and five were toxic (one fatally poisonous). In view of the fact that the reserve's mycobiota is basically unknown, it is imperative that fungal research be continued in the region.

Materials & methods

Specimens were collected in oak forests in the Cuicatlán district. Digital pictures, field data, and macro- and microscopical characterization of samples were performed. Collections are deposited in the Fungus Collection of the National Herbarium, Institute of Biology, National Autonomous University of México (MEXU). Colour codes in descriptions follow Kornerup & Wanscher (1978). Morphological structures were observed using a stereomicroscope and compound light microscope. Basidiomes were sectioned and mounted in ammonia water (1%), KOH (5%), Melzer reagent, neutral red (1%), and cotton blue in lactic acid solutions. Species were identified consulting Bas (1969), Jenkins (1977), Arora (1986), Pérez-Silva & Herrera (1991), Phillips (1991), and Tulloss et al. (1992).

Taxonomy

Amanita caesarea (Scop.) Pers., Syn. Meth. Fung. Pars 2: 252 (1801). Fig. 1

Basidiome 90–120 mm high. Pileus 5.5–10.5 mm diam., convex, becoming flatter in age, with long striate margin; disc high red to vivid red (11A8), paler toward the margin. Lamellae 8 mm broad, adnate, with entire edge, pale yellow (4A3). Stipe 9–12 × 8–17 cm, pale yellow, with darker orange fiber or patches; annulus pendulous, membranous, yellowish, attached to the upper stem, often striate; no basal bulb, white volval sac. Context white to yellowish. Odor & taste pleasant.

Basidiospores 8–16.5 × 5.5–8 µm, elliptical, thin-walled; basal cylindric apiculus; uniguttulate, broadly ellipsoid; hyaline, inamyloid. Basidia 38.5–49.5 × 10–11 µm, tetrasporic, with basal clamp connections.

Ecology—Solitary (rarely in groups) in pine–oak woods during July–November; mycorrhizal; widely distributed in México, where it is reported as an edible of excellent culinary value; commonly called "yellow fungus" (Pérez-Silva & Herrera 1991).

Specimens examined: **MEXICO. Oaxaca: Cuicatlán District**, San Pedro Jocotipac, Ciénega de Cochino, 17 Nov 2013, A.J. Medina-Ortíz, F. Medina Ruíz, A. de la Cruz Martínez (MEXU 27820); El Sótano, 11 Jul 2014, E. Pérez-Silva, A.J. Medina-Ortíz, A. García-Mendoza, F. Hernández (MEXU 27827).

Comments—*Amanita caesarea* is easily distinguished by its bright yellow gills and stipe, brilliant red to orange cap with striate margin, and voluminous white

FIGURES 1–8. *Amanita* species basidiomata. 1: *A. caesarea* (MEXU 27827). 2: *A. flavoconia* (MEXU 27828). 3: *A. fulva* (MEXU 27833). 4: *A. onusta* (MEXU 27823). 5: *A. pantherina* (MEXU 27835). 6: *A. rubescens* (MEXU 27832). 7: *A. vaginata* (MEXU 27824). 8: *A. verna* (MEXU 27825).

volva (Arora 1986). Fresh mushrooms are sold at markets and along roadsides in México (Montoya et al. 2001) and the United States (Volk 2017). *Amanita jacksonii* is similar, but differs by its larger, bright orange-red basidiome and occurrence in northern mixed forests of Canada.

Amanita flavoconia G.F. Atk., J. Mycol. 8(3): 110 (1902). FIG. 2

BASIDIOME 80 mm high. PILEUS 40–60 mm diam., convex, becoming broadly flatter when maturing, yellowish red (8B8); surface often viscid, with bright yellow universal veil remnants; not striate margin. LAMELLAE 7 mm broad, white to pale yellow (4A3), free from stem, with entire edge. STIPE 60–80 × 5–9 mm, white to yellowish, membranous annulus to the apex, pale yellow; swollen basal bulb, 20 mm diam., covered with yellow floccose veil fragments, friable volva. CONTEXT white. ODOR & TASTE pleasant.

BASIDIOSPORES 8–9 × 6–7 µm, ovoid, hyaline, amyloid, thin-walled. BASIDIA 33–38 × 8–8.5 µm, clavate, tetrasporic. PILEIPELLIS hyphae 2–5 µm wide, gelatinized filamentous; oleiferous hyphae 2–4 µm wide.

Ecology—Solitary in pine-oak woods; fructification during July–November; wide distribution in México (Pérez-Silva & Herrera 1991). Villanueva-Jiménez et al. (2006) cited from Ixtlán, Oaxaca.

Specimen examined: **MEXICO. Oaxaca: Cuicatlán District**, San Pedro Jocotipac, Ciénega de Cochino, 17 Nov 2013, A.J. Medina-Ortíz, F. Medina-Ruíz, A. de la Cruz Martínez (MEXU 27821); El Sótano, 11 Jul 2014, E. Pérez-Silva, A.J. Medina-Ortíz, A. García-Mendoza, F. Hernández (MEXU 27828).

Comments—*Amanita flavoconia* has been reported as toxic in several localities in USA (Metzler & Metzler 1992) and may cause gastrointestinal mycetism. Benedict et al. (1966) did not detect ibotenic acid or muscimol nor did Chilton & Ott (1976) find toxic metabolites. Aroche et al. (1984) reported presence of amanitins.

Amanita flavorubescens G.F. Atk., J. Mycol. 8(3): 111 (1902).

Basidiome 60 mm high. Pileus 40–60 mm diam., convex, becoming flatter when maturing, orange yellow (4A8); thick yellow warts of volva around center. Lamellae 5 mm broad, white to pale yellow (4A3), free from stipe, white pulverulent edge. Stipe 50–70 × 3–7 mm, yellow to pale yellow, narrower at the apex, pruinose to powdery; annulus membranous, skirt-like; basal bulb, 5–15 mm diam., with yellowish margin. Context white, reddish at the base. Odor & taste not distinctive.

Basidiospores 9–10 × 5–7 µm, ellipsoid, thin-walled, uniguttulate, with basal eccentric apiculus, amyloid. Basidia tetrasporic. Pileipellis hyphae 2–5 µm wide, filamentous; oleiferous hyphae present.

Ecology—Solitary in pine-oak woods during July–November; mycorrhizal; widely distributed in Chihuahua, Estado de México, Hidalgo and Morelos States of México (Pérez-Silva & Herrera 1991). Edibility unknown.

Specimen examined: **MEXICO. Oaxaca: Cuicatlán District**, San Pedro Jocotipac, Ciénega de Cochino, 17 Nov 2013, A.J. Medina-Ortíz, F. Medina Ruíz, A. de la Cruz Martínez (MEXU 27822); Santa María Pápalo, 12 Jul 2014, E. Pérez-Silva, A.J. Medina-Ortíz, A. García-Mendoza, F. Hernández (MEXU 27829).

Comments—*Amanita flavorubescens* is easily recognized by its striking yellow pileus with yellow warts, free white crowded lamellae with floccose edges, yellowish stipe with a superior annulus and slightly reddish persistently bulbous base.

Amanita fulva Fr., Observ. Mycol. 1: 2 (1815). Fig. 3

Basidiome 90 mm high. Pileus 25–45 mm diam., oval, becoming broadly convex or flat in age; brownish grey (8D2) to dark brown (8F5); surface viscid

when moist; remarkably striate margin; Lamellae 4 mm broad, whitish (9A1), free from the stem. Stipe 95 × 5 mm, with very fine hairs, without annulus; the base enclosed by a white large volva. Context white. Odor & taste indistinct.

Basidiospores 8–10 × 9 µm, globose, apiculus basal and eccentric, hyaline, inamyloid. Basidia 23–38 × 5–7 µm, tetrasporic. Pileipellis hyphae 2–8 µm wide, thin filamentous, brown.

Ecology—Solitary in pine-oak woods during July; in México widely distributed in Durango, Estado de México, Hidalgo, Morelos, Puebla and Veracruz states (Pérez-Silva & Herrera 1991). Edible, although toxic when raw or poorly cooked (Pérez-Silva 2004).

Specimen examined: **MEXICO. Oaxaca: Cuicatlán District**, San Pedro Jocotipac, El Sótano, 11 Jul 2014, E. Pérez-Silva, A.J. Medina-Ortíz, A. García-Mendoza, F. Hernández (MEXU 27830); Santa María Pápalo, 11 Jul 2014, E. Perez-Silva, A.J. Medina-Ortíz, A. García-Mendoza, F. Hernández (MEXU 27833).

Comments—*Amanita fulva* is easily recognized by its often umbonate pileus, striate margin, free whitish lamellae, the stipe lacking an annulus, large white volva, and inamyloid spores.

Amanita onusta (Howe) Sacc., Syll. Fung. 9: 1 (1891). Fig. 4

Basidiome 90–180 mm high. Pileus 45–90 mm diam., convex, expanding to flat in age; white (10E2) to pale gray (1B1), covered with dark grey to brownish grey pyramidal warts, 5 mm high (but shorter toward margin), veil fragments frequent. Lamellae 10 mm broad, white to pale gray (1B1), ventricose, adnexed, floccose. Stipe 90–180 × 15–25 mm, brownish-grey, paler towards the top; annulus apical but lost in age; base a ventricose to napiform basal bulb, 25–35 mm diam.; volva floccose, fibrillose, brownish grey, remnants in circles around stipe. Context whitish. Odor & taste unpleasant.

Basidiospores 9–10 × 6–7 µm, ellipsoid, thin-walled, amyloid. Basidia 38–44 × 6–9 µm, pyriform; clamp connections present. Pileipellis thick layer interwoven, hyphae 3 µm diam.; oleiferous hyphae abundant.

Ecology—Solitary in pine-oak woods during November; mycorrhizal; previously reported in México from Estado de México and Veracruz State (Pérez-Silva & Herrera, 1991) and now for the first time in Oaxaca State. Little is known regarding its edibility, but its unpleasant odor probably deters consumption.

Specimen examined: **MEXICO. Oaxaca: Cuicatlán District**, San Pedro Jocotipac, Ciénega de Cochino, 17 Nov 2013, A.J. Medina-Ortíz, F. Medina Ruíz, A. de la Cruz Martínez (MEXU 27823).

Comments—*Amanita onusta* is characterized by its white to pale grey pileus covered with dark gray to brownish grey pyramidal warts, its dirty white stipe with a paler apex, and elliptical amyloid spores.

Amanita pantherina (DC.) Krombh.,
Naturgetr. Abbild. Schwämme 4: t.29 f. 10-13 (1836). Fig. 5

Basidiome 50–150 mm high. Pileus 50–70 mm diam., convex, finally flattened; brownish grey (9D3), surface slightly viscid, covered with adnate white warts. Lamellae 8 mm broad, white, free, narrowed to the stem. Stipe 80–120 × 20–50 mm, white, apical annulus, smooth; basal bulb, volva with 2–3 concentric rings. Context white. Odor & taste unpleasant.

Basidiospores 7–10 × 6–9 µm, ovoid, thin-walled, with hilar appendix. Basidia 38–55 × 10–15 µm.

Ecology—Solitary in pine-oak woods during July; reported from Chihuahua, Hidalgo, Estado de México, and Puebla states (Pérez-Silva & Herrera 1991) and from Ixtlán Mountain range in Oaxaca State by Villanueva-Jiménez et al. (2006). Although there is no data regarding intoxication from the Cuicatlán District, *Amanita pantherina* is known to produce ibotenic acid (Pérez-Silva 2004; Pérez-Silva et al. 2006, 2008), which causes nervous mycetism.

Studied material. **MEXICO. Oaxaca: Cuicatlán District**, San Pedro Jocotipac, El Sótano, 11 Jul 2014, E. Pérez-Silva, A.J. Medina-Ortíz, A. García-Mendoza, F. Hernández (MEXU 27831); Santa María Pápalo, 12 Jul 2014, E. Pérez-Silva, A.J. Medina-Ortíz, A. García-Mendoza, F. Hernández (MEXU 27835).

Comments—*Amanita pantherina* is easily recognized by its viscid brownish pileus decorated with white to cream patches and initially striate curved margin, free white lamellae, white stipe with a superior annulus and basal bulb, and its 2–3 concentrically ringed volva.

Amanita rubescens Pers., Tent. Disp. Meth. Fung.: 67 (1797). Fig. 6

Basidiome 60–80 mm high. Pileus 40–85 mm diam., convex, becoming flat; reddish to reddish white (13A2); surface covered with adnexed warts; spotted reddish where injured. Lamellae 4 mm broad, white to pale reddish (13A2), free. Stipe 70–100 × 10-25 mm, concolorous with the pileus, white; annulus large, membranous; basal bulb, staining reddish; volva scaly, reddish grey (7B2), sometimes leaving remnants in circles. Context white, staining pinkish when injured. Odor & taste pleasant.

Basidiospores 8–9 × 5–7 µm, elliptical, thin-walled, smooth, amyloid. Basidia 44–47 × 8 µm, cylindrical, tetrasporic.

Ecology—Solitary in pine-oak woods during July, widely distributed in México from Baja California, Chihuahua, Distrito Federal, Durango, Hidalgo, Jalisco, Michoacán, Morelos, Nuevo León, Oaxaca, Puebla, Sonora, Veracruz, and Zacatecas states (Pérez-Silva & Herrera 1991). Considered edible after discarding the first cooking water, which removes the toxic protein rubescenslysine. Nonetheless, *Amanita rubescens* is not usually consumed when parasitized by *Hypomyces hyalinus*.

Studied material. **MEXICO. Oaxaca: Cuicatlán District**, San Pedro Jocotipac, El Sótano, 11 Jul 2014, E. Pérez-Silva, A.J. Medina-Ortíz, A. García-Mendoza, F. Hernández (MEXU 27832).

Comments—*Amanita rubescens* is easily recognized by its white to reddish pileus.

Amanita vaginata (Bull.) Lam., Encycl. Méth. Bot.. 1(1): 109 (1783). Fig. 7

Basidiome 70 mm high. Pileus 30 mm diam., ovoid, becoming flat with a low umbo; brownish grey (7E2), viscid when wet, covered with membranous white universal veil patches; margin radially striate. Lamellae 5 mm broad, close, free, white to pallid (1A2). Stipe 60–70 mm long, white, with scales; base enclosed in a sac-like volva, membranous, white. Context white. Odor & taste pleasant.

Basidiospores 10–11 µm, globose, hyaline, inamyloid. Basidia 50–60 µm, tetrasporic. Pileipellis with filamentous cuticle and abundant oleiferous hyphae.

Ecology—Solitary in pine-oak woods during November; widely distributed in México from Chihuahua, Estado de México, Hidalgo, and Oaxaca states (Pérez-Silva & Herrera 1991). Considered edible.

Studied material. **MEXICO. Oaxaca: Cuicatlán District**, San Pedro Jocotipac, Ciénega de Cochino, 17 Nov 2013, A.J. Medina-Ortíz, F. Medina-Ruíz, A. de la Cruz-Martínez (MEXU 27824).

Comments—*Amanita vaginata* contains hemolysins and may cause severe gastrointestinal mycetism when consumed raw. Pérez-Silva & Herrera (1991) cite several common names for this species.

Amanita verna (Bull.) Lam., Encycl. Méth. Bot. 1(1): 113 (1783). Fig. 8

Basidiome 100 mm high. Pileus 70–90 mm diam., hemispheric with flattened center, becoming applanate; white (23A1) to whitish cream (24A1), occasionally with some scales. Lamellae 4–5 mm broad, white (24A1), free, edges serrate, floccose. Stipe 80–90 × 40–50 mm, cylindrical, white, pale yellow in 10% KOH; annulus superior, membranous, fragile;

basal bulb 40–50 × 30–50 mm, covered with a persistent membranous saccate volva. Context white. Odor & taste unpleasant. Edibility poisonous.

Basidiospores 9–10 × 6–8 µm, ellipsoid, thin-walled, hyaline, amyloid. Basidia 40–44 × 5–6 µm, tetrasporic, yellowish.

Ecology—Solitary in pine-oak woods during November; widely distributed in México from Durango, Estado de México, Guanajuato, Guerrero, Hidalgo, Michoacán, Morelos, Sonora, and Veracruz states (Pérez-Silva & Herrera 1991); previously reported from Ixtlán belt of Oaxaca State (Villanueva-Jiménez et al. 2006).

Studied material. **MEXICO. Oaxaca: Cuicatlán District**, San Pedro Jocotipac, Ciénega de Cochino, 17 Nov 2013, A.J. Medina-Ortíz, F. Medina Ruíz, A. de la Cruz Martínez (MEXU 27825); Santa María Pápalo, 12 Jul 2014, E. Pérez-Silva, A.J. Medina-Ortíz, A. García-Mendoza, F. Hernández (MEXU 27834).

Comments—*Amanita verna* is similar to *A. virosa* Bertill., which differs in its positive reaction in 5% KOH and ovoid amyloid spores. Extremely toxic, *A. verna* frequently causes fatalities and cyclopeptide mycetism due to amanitins and other toxins; commonly known as "crazy fungus" (Pérez-Silva 2004; Pérez-Silva et al. 2006, 2008). Bresinsky & Besl (1990) cite the species as mycorrhizal.

Discussion

Five of the nine *Amanita* species reported here are toxic, causing cyclopeptide mycetism (*A. verna*), pantherina mycetism (*A. pantherina*), and possibly a type of gastrointestinal mycetism when eaten raw (*A. flavoconia*, *A. flavorubescens*, and *A. vaginata*). *Amanita caesarea* is the only wild species with excellent cooked or raw edibility, although *A. rubescens* can be safely eaten after its boiling water is discarded. The edibility/toxicity of *A. onusta* remains unknown.

All nine amanitas are reported for the first time from Tehuacán-Cuicatlán biosphere reserve, which extends their known Mexican distribution.

Acknowledgments

This article is dedicated to Dr. Teófilo Herrera, Emeritus Researcher of UNAM, for his outstanding academic trajectory and forming mycologists in Mexico. We thank SNI for financial support, Dr. Martín Esqueda and Dr. Gabriel Moreno for pre-submission expert reviews, Dr. Shaun R. Pennycook for critical reading of the manuscript and suggestions, MSc. C.E. Aguirre-Acosta for curatorial support in MEXU, and David Esqueda for translation.

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MYCOTAXON

ISSN (print) 0093-4666 (online) 2154-8889 Mycotaxon, Ltd. ©2017

October–December 2017—Volume 132, pp. 943–950

https://doi.org/10.5248/132.943

Thelephora iqbalii sp. nov. from the Himalayan moist temperate forests of Pakistan

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Abstract—A new thelephoroid species, *Thelephora iqbalii*, collected from the Himalayan moist temperate (HMT) forests of Pakistan, is characterized by small coralloid basidiomata bearing long, narrow ridges with fine hairs on their branches and hymenia that are cyanescent in KOH. An ITS-based phylogeny comparing *T. iqbalii* with other *Thelephora* species is also presented.

Key words—*Basidiomycota,* DNA, *Thelephoraceae*, angular lobate basidiospores

Introduction

The genus *Thelephora* Ehrh. ex Willd. is cosmopolitan (Corner 1968; Stalpers 1993; Kõljalg 1996; Maas Geesteranus 1971, 1975) and represented by 52 species worldwide (Kirk et al. 2008, Ramírez-López et al. 2017, Vizzini et al. 2016). Its basidiomata are distinguished by their pileate and stipitate/sessile or sometimes resupinate forms (Ahmad 1972).

Thelephora basidiomata range in shape from coral-like to distinctly pileate (Corner 1968). However, morphology alone is not always sufficient for correct identification. Recent molecular analyses have contributed to a better understanding of basidiomycete diversity (Gardes & Bruns 1993) and ITS-nrDNA primers are widely being used for this purpose (EI Karkouri et al. 2005, 2006; Gardes & Bruns 1993; Horton 2002).

The Himalayan moist temperate forests (HMT) have been previously included among 25 biodiversity hotspots in Indo-Burma (Myers et al. 2000), from which they were separated and designated as independent among the 34 currently recognized hotspots of biodiversity (Mittermeier et al. 2011).

Eight *Thelephora* species have previously been reported from Pakistan: *T. anthocephala* (Bull.) Fr., *T. arbuscula* Corner, *T. caryophyllea* (Schaeff.) Pers., *T. fucoides* Corner, *T. palmata* (Scop.) Fr., *T. penicillata* (Pers.) Fr., and *T. terrestris* Ehrh. (Ahmad 1956, 1972; Ahmad et al. 1997). Below we describe a new thelephoroid species from the HMT forests of Pakistan based on morphological and molecular evidence.

Materials & methods

Table 1. *Thelephora* rDNA sequences used in phylogenetic analyses

Taxon	Accession No.	Voucher No	Country
Thelephora americana	AY219838.1	UAMH 9578	Canada
Thelephora anthocephala	DQ974771.1	src614	USA
	AF272927.1	TAA165304	Estonia
Thelephora caryophyllea	GU234018.1	O75453	Netherlands
	AJ889980.1	TL-6566	Denmark
	EU326158.1	105	Austria
	EF655705.1	IB60087	Austria
Thelephora cf. penicillata	EU819494.1	NAMA503	USA
Thelephora ganbajun	EU696946.1	Gb279	China
Thelephora iqbalii	**JX241471**	**MH810**	**Pakistan**
Thelephora palmata	EU819443.1	JMP0085	USA
	AF272919.1	TAA149550	Estonia
Thelephora aff. palmata	AB509755.1	350-421	Japan
Thelephora penicillata	U83484.1	LTT8, Bruns Herbarium, UCB	USA
Thelephora pseudoterrestris	AF272907.1	TAA159625	Estonia
	AB453027.1	CU: Micro: Nan-M11	Thailand
Thelephora regularis	U83485.1	OSC: JMT17371	USA
Thelephora sublilacina	EF493288.1	UP161	Sweden
Thelephora terrestris	HM189959.1	BB23-305-Ah-Pi-150506 (DNA64)	Germany
	HM189958.1	BB64-301-Oh-Pi-150506 (DNA43)	Germany
Thelephoraceae sp. 'Taylor #4'	U83468.1	—	USA
Thelephoroid sp. nw1	AF323110.1	—	USA

Bold indicates sequence generated in this study; all others downloaded from GenBank.

Collection and morphological analysis

During exploration of Himalayan moist temperate forests, an unidentified *Thelephora* specimen associated with *Abies pindrow* was collected near a helipad, in Khanspur, Abbotabad district, Khyber Pakhtunkhwa province, Pakistan. The fresh specimen was morphologically characterized following Corner (1968), and small portions of fresh hymenium were placed into 2% CTAB buffer and stored at –20 °C for future molecular study. The remaining material was dried with a fan heater overnight before storing in Ziploc® bags. Basidiospores, basidia, basidioles and sterigmata were observed in 1% KOH under a compound microscope and measured using an ocular micrometer; drawings were made with the aid of a camera Lucida. Dried specimens are deposited at the Herbarium of the Department of Botany, University of the Punjab, Lahore (LAH).

Molecular analysis

Genomic DNA was extracted with a CTAB method (Gardes & Bruns 1993) modified for silica emulsion binding and purified (Gene-Clean; Q-Biogene). Polymerase chain reactions (PCR) for the ITS-nrDNA region were carried out using the fungus-specific primers ITS1F/ITS4 following protocols described by Gardes & Bruns (1993). PCR products were purified with QIAquick (Qiagen Inc.), and sequenced by Macrogen (South Korea). Maximum Likelihood and Maximum Parsimony methods generated a phylogeny comparing *Thelephora iqbalii* with other thelephoroid species. A total of 22 sequences (21 downloaded from GenBank) were used in the phylogenetic analyses (Table 1), and cladograms were recovered using Mega5. Sequences were aligned with BioEdit version 7.0 (Hall 1999) and ClustalX version 2.0 (Larkin et al. 2007) and corrected manually. All the gaps were treated as 'missing data'. The ITS sequence generated from the holotype was deposited in GenBank.

Results

Thelephora iqbalii Khalid & Hanif, **sp. nov.** Fig. 1

MycoBank MB 800830

Differs from *Thelephora fucoides* by its angular lobate basidiospores and from *T. penicillata* by its coralloid basidiomata and its smaller basidiospores.

Type: Pakistan, Khyber Pakhtunkhwa province, Abbotabad district, Khanaspur, near helipad, 1972 m a.s.l., associated with *Abies pindrow* (Royle ex D. Don) Royle, solitary to gregarious, 22.VIII.2010, M. Hanif, MH810 (**Holotype**, LAH 20810.2; GenBank JX241471).

Etymology: dedicated to Prof. Dr. S.H. Iqbal in honor of his contributions to the knowledge of fungi.

Basidioma 4–5 × 2–4 cm, coralloid, individual branches 1–2 mm thick, long narrow ridges, penicillate with fine hairs on long pointed tips, tip

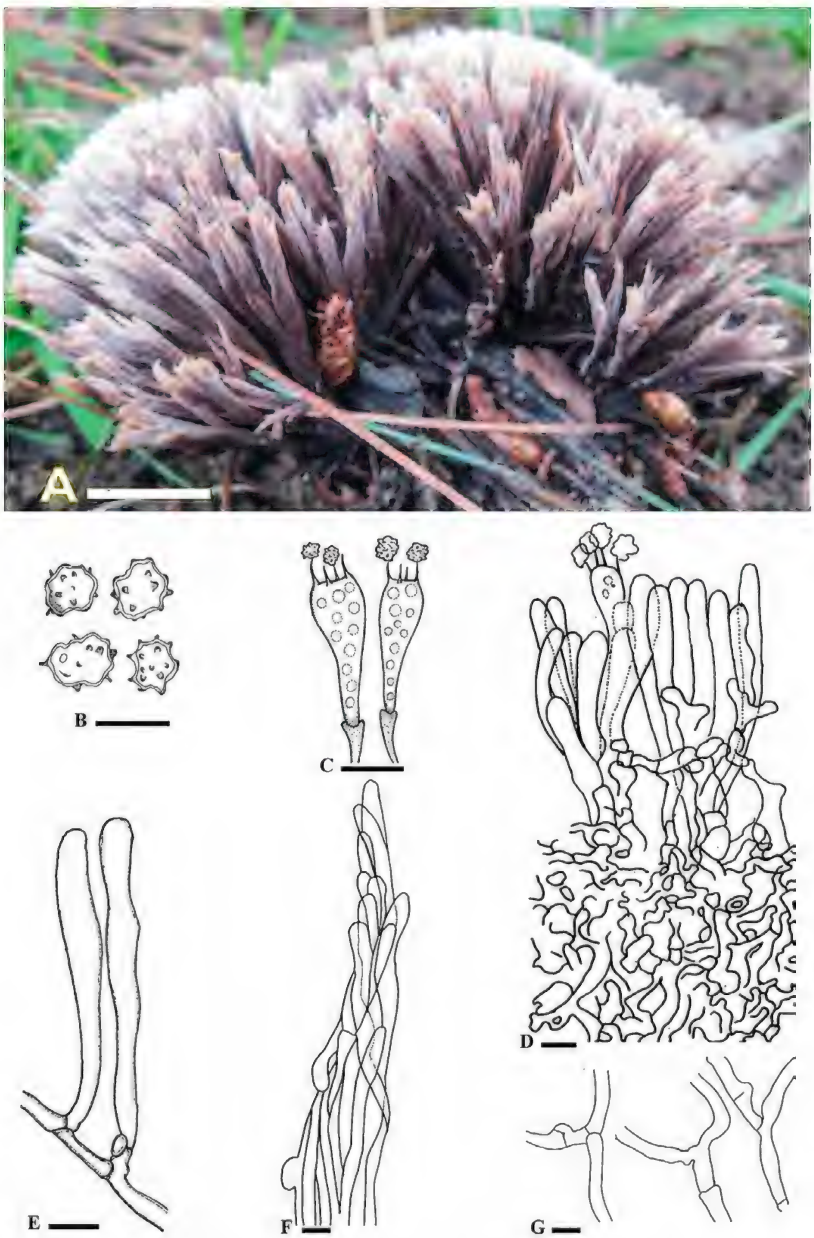

FIG. 1. *Thelephora iqbalii* sp. nov. A. Basidiocarp in situ; B. Basidiospores; C. Basidia; D. Hymenial tissue; E. Basidioles; F. Hair-like appendages of pointed tips; G. Tramal hyphae. Bars: A = 1 cm, B–G = 10 µm.

fibers typically serrate; branches pinkish white at the tip to grayish brown at the base. Context solid, dry.

Hyphal system monomitic, multi-septate, connective hyphae 6 µm diam., skeletal hyphae 5 µm diam., tramal hyphae encrusted with globose to sub-globose crystals, cyanescent in 1% KOH. Basidia 50–75 × 8–10 µm, cylindrical to clavate, with basal clamps, smooth, 2–4 sterigmate, hyaline, guttulate, light blue in KOH. Basidioles 34–40 × 4–8 µm, smooth, thin walled, hyaline, clavate, apex obtuse, light blue in KOH. Basidiospores 6–8.5 × 5–6.5 µm, reniform, angular lobate or scarcely lobate, thick-walled and verrucose, tuberculate ornamentation, brown in lactic acid, light blue in KOH.

Additional material examined *Thelephora fucoides*: MALAYSIA: Pahang, Cameron Highlands, 06.08.1934, E.J.H. Corner (E 00192884, holotype).

Phylogenetic analysis

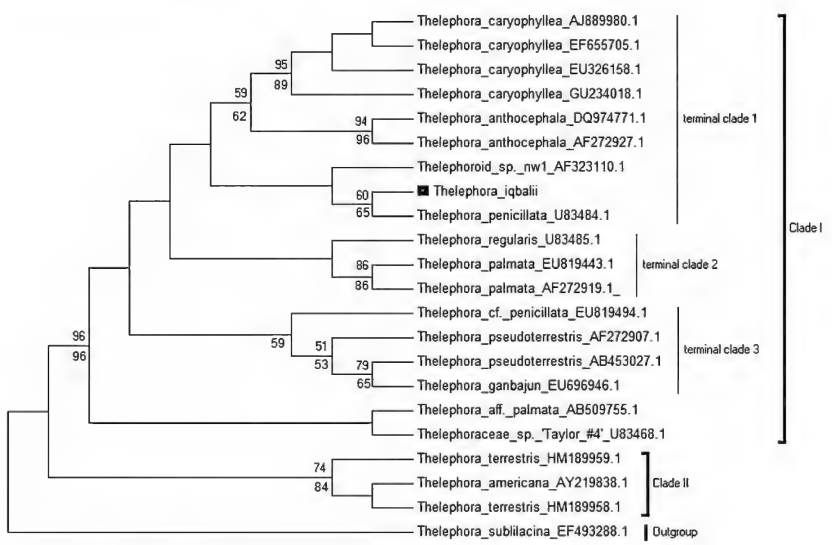

Fig. 2. Cladogram representing phylogenetic analysis inferred from Maximum Parsimony (bootstrap percentages above the lines) and Maximum Likelihood (bootstrap percentages below the lines).

Amplification of the ITS-nrDNA region produced one sequence of 654 bp. Initial BLAST analysis showed a 91% maximum identity with *Thelephora penicillata* (GenBank U83484) with 100% query coverage.

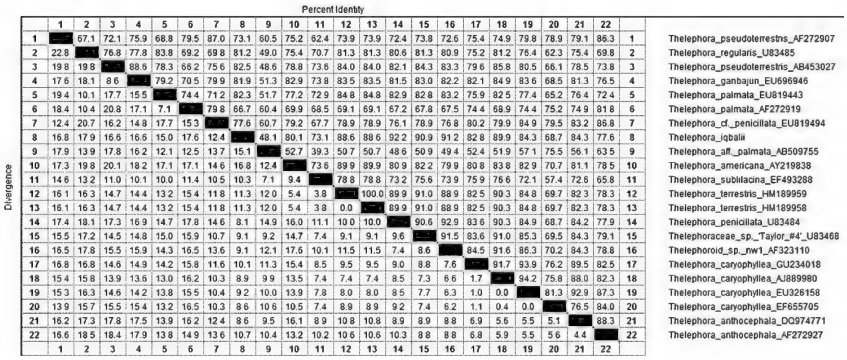

FIG. 3. Percent genetic divergence and percent similarity for *Thelephora* spp.

After trimming 84 unaligned characters from the 3′ and 5′ ends of the 789-bp ITS region, 705 characters were used for final analysis, of which 360 were conserved, 301 were variable but parsimony uninformative, 172 were parsimony informative, and 133 were singletons. The phylogenetic tree generated two major clades (FIG. 2). *Thelephora iqbalii* clustered with *T. penicillata* within terminal clade I of clade I, and *T. anthocephala* and *T. caryophyllea* appeared as sister species to *T. iqbalii*. *Thelephora iqbalii* and *T. penicillata* shared 91.8% genetic characters/nucleotides and showed an 8.1% genetic divergence (FIG. 3). However, we should note that the clustering of all these species in terminal clade I of clade I (FIG. 2) was not supported by both analyses.

Discussion

Eight *Thelephora* species have been previously recorded from Pakistan (Ahmad 1956, 1972). Our new species, *T. iqbalii,* which is supported both by morphological and ITS sequence analysis, shares the basic morphological characters with other *Thelephora* species: spiny to warty and often lobed basidiospores, drab basidiocarp coloration, and blue to green KOH reactions (Corner 1968). Hanif (2012) reported a rich diversity of *Thelephorales* in subterranean ectomycorrhizal communities in HMT forests, and *T. iqbalii* is expected to exhibit a similar ectomycorrhizal association typical of *Thelephora* species elsewhere in Pakistan.

In Ahmad's (1972) key to *Thelephora* species in Pakistan, *T. iqbalii* would fall close to *T. fucoides,* which differs by its echinulate basidiospore ornamentation (Corner 1968). Morphological and phylogenetic analyses

imply a close alliance between *T. penicillata* and *T. iqbalii*. However *T. penicillata* can be distinguished by its resupinate basidiomes with prostrate to suberect branches, its smaller basidiomata with margins that are cristate, penicillate ramose-spiculose, or fimbriate, and its slightly larger basidiospores (Corner 1968).

Acknowledgements

We are sincerely thankful to Prof. Juliano M. Baltazar (Centro de Ciências da Natureza, Campus Lagoa do Sino, Universidade Federal de São Carlos (UFSCar), Buri, São Paulo, Brazil) and Dr. Najam-ul-Sehar Afshan, (Centre for Undergraduate Studies, University of the Punjab, Lahore, Pakistan) for acting as pre-submission reviewers. We are also thankful for Dr. Stephan Helfer (Herbarium Royal Botanic Garden Edinburgh, Scotland, UK) for sending the holotype of *Thelephora fucoides* for morphological comparison.

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MYCOTAXON

ISSN (print) 0093-4666 (online) 2154-8889 Mycotaxon, Ltd. ©2017

October–December 2017—Volume 132, pp. 951–955

https://doi.org/10.5248/132.951

Three new combinations in *Drepanopeziza* for species on poplar

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Abstract—Three species of *Drepanopeziza* that cause diseases of poplars have been known under different scientific names for their sexual and asexual morphs, which is no longer allowed with the change to one scientific name for fungi. For each of these species, the oldest epithet is provided by the asexual morph; however, neither of the generic names available for the asexual morphs can be used for these species. As a consequence new combinations for the three species are required and can be accomplished by applying the oldest asexual morph epithet in the genus *Drepanopeziza*. The following new combinations are made: *Drepanopeziza brunnea*, *D. castagnei*, and *D. populi*.

Key words—fungal nomenclature, plant pathogen, pleomorphic fungi

Introduction

Following a careful study of type and other specimens, three species of *Drepanopeziza* that cause diseases of poplar were delineated by Spiers & Hopcroft (1998), who cited separate scientific names for their sexual and asexual morphs. Because the International Code of Nomenclature for algae, fungi and plants (ICN, McNeill et al. 2012) requires the adoption of one scientific name for different morphs of one fungal taxon, these sexual and asexual names now compete for use. For these three *Drepanopeziza*

species—*D. populi-albae, D. populorum,* and *D. tremulae*—the asexual morphs provide the oldest epithets. Pirozynski (1974a,b,c) presented an account of each of these species: *D. tremulae* as *Marssonina brunnea, D. populi-albae* as *Marssonina castagnei,* and *D. populorum* as *Marssonina populi*, while Spiers (1988) included a conidia-based key to these *Marssonina* species. Gremmen (1965) recognized the same three taxa in *Drepanopeziza* but described one of them as a new species, *D. punctiformis* Gremmen 1965, apparently unaware of the earlier synonym *D. tremulae* Rimpau 1962.

In determining the generic names to use for competing synonyms, Rossman et al. (2016) recommended that *Drepanopeziza* (Kleb.) Jaap 1914 be used rather than the competing generic names *Gloeosporidiella* Petr. 1921 or *Gloeosporium* Desm. & Mont. 1849. All three of these species of *Drepanopeziza* on poplar have previously been placed in the genus *Marssonina;* however, these species are not congeneric with the *Marssonina* type species, *M. potentillae* (Desm.) Magnus 1906, now recognized as *Diplocarpon earlianum* (Ellis & Everh.) F.A. Wolf 1924 (Johnston et al. 2014). *Diplocarpon* F.A. Wolf 1912 is now regarded as the correct generic name for species formerly classified in *Marssonina* Magnus 1906. Some authors use the *Drepanopeziza* names for these species, as determined by Spiers & Hopcroft (1998); however, the asexual morph names provide older epithets and are used more commonly (albeit in the asexual morph genera that are no longer available for use). Rather than conserve the less commonly used sexual morph names, it seems least disruptive to make new combinations in *Drepanopeziza* using the asexual morph names, as proposed here.

Taxonomy

Drepanopeziza brunnea (Ellis & Everh.) Rossman & W.C. Allen, **comb. nov.**

MycoBank MB822026

≡ *Gloeosporium brunneum* Ellis & Everh., J. Mycol. 5: 154 (1889).

Type: U.S.A.: New Jersey, Newfield, on leaves of *Populus candicans*, Aug 1889, Ellis & Everhart in North American Fungi, second ser. 2444 (**Lectotype designated here**, BPI 402970, under *Marssonina* brunnea).

≡ *Marssonina brunnea* (Ellis & Everh.) Magnus, Hedwigia 45: 88 (1906).

= *Drepanopeziza tremulae* Rimpau, Phytopathol. Z. 43: 288. (1962).

Type: Switzerland, Kt. Zürich, am Uetliberg, bei Station Uitikon-Waldegg, on *Populus tremula*, 7 Mai 1961, Rimpau (holotype, ZT-Myc 57794).

= *Drepanopeziza punctiformis* Gremmen, Nova Hedwigia 9: 172 (1965).

Type: Batava [the Netherlands], Meppel, in foliis *Populi euroamericana* 'Serotina', 9.X.1961, Gremmen (holotype, herb. Gremmen 1811).

Drepanopeziza brunnea causes a leaf spot disease of *Populus* that occurs worldwide in temperate regions (Callan 1998, Farr & Rossman 2017). Spiers & Hopcroft (1998) concluded that *D. tremulae* provided the oldest name for the sexual morph of which *D. punctiformis* is a synonym. Pirozynski (1974a) presented a description of this species using the asexual morph name *Marssonina brunnea* based on *Gloeosporium brunneum*. Because neither *Gloeosporium* nor *Marssonina* can be used as a generic name for this species, the name *D. brunnea* is established based on *Gloeosporium brunneum*.

The type of *G. brunneum* was issued as Ellis & Everhart, North America Fungi second series 2444, and the specimen at BPI is designated here as the lectotype. According to Spiers & Hopcroft (1998), "type material of *D. tremulae* was not deposited by Rimpau with other specimens at ZT and therefore was probably lost." However, the holotype specimen was later found at ZT (R. Berndt pers. comm. 31 Jan 2017).

Drepanopeziza castagnei (Desm. & Mont.) Rossman & W.C. Allen, comb. nov.
MycoBank MB822027

≡ *Gloeosporium castagnei* Desm. & Mont., Ann. Sci. Nat. Bot., sér. 3, 12: 295 (1849). Type: France, Aix, on *Populus alba*, 1852, Castagne, ex Herb. Bois, Shear Type and Rarities Ser. 1 (**Lectotype designated here**, BPI barcode 797921).

≡ *Marssonina castagnei* (Desm. & Mont.) Magnus, Hedwigia 45: 88 (1906).

= *Pseudopeziza populi-albae* Kleb., Haupt- und Nebenfruchtform. Ascomyz. 1: 344 (1920) ["1918"]. Type: Germany, Berlin, Dahlem, Garten der Biologischen Reichsanstalt, on leaves of *Populus alba*, Oct 1913, Laubert (holotype, HBG).

≡ *Drepanopeziza populi-albae* (Kleb.) Nannf., Nova Acta R. Soc. Scient. Upsal., Ser. 4 8(2): 170 (1932).

Drepanopeziza castagnei causes a leaf disease of poplar that is widespread in temperate regions (Callan 1998, Farr & Rossman 2017). Spiers & Hopcroft (1998) considered *Marssonina castagnei* based on *Gloeosporium castagnei* to be the asexual morph of *D. populi-albae*. Pirozynski (1974b) provided an account of this species under the asexual morph name *Marssonina castagnei*. Because neither *Gloeosporium* nor *Marssonina* can be used as a generic name for this species, it is least disruptive to make a new combination in *Drepanopeziza* with the oldest and familiar epithet *castagnei*.

Although Spiers (1988) mentioned that "Type and isotype material of *M. castagnei* was obtained from..." BR and PC, he did not present details of the specimens, so his work cannot be considered lectotypification of the name *G. castagnei*. A specimen matching the protologue exists at BPI, and this specimen is designated here as the lectotype. According to Stafleu & Cowan (1976) Klebahn's specimens are housed at B, but Robert Lücking

(pers. comm.) reported that the type of *Pseudopeziza populi-albae* is not found there. Rather, a specimen matching the protologue was located at HBG.

Drepanopeziza populi (Lib.) Rossman & W.C. Allen, **comb. nov.**

MycoBank MB 822028

≡ *Leptothyrium populi* Lib., Pl. Crypt. Arduenna, fasc. 3: no. 257 (1834).
Type: France, on *Populus*, autumn (**Lectotype designated here**, FH).

≡ *Marssonina populi* (Lib.) Magnus, Hedwigia 45: 88 (1906).

= *Trochila populorum* Desm., Pl. Crypt. Nord France Ed. (2) 2, no. 451 (21 Mar 1857).
Type: France, on dried leaves of *Populus nigra*, spring, 1857, Grance, Herb. Desmazières (lectotype, PC; isolectotypes, BR, BPI-bound).

≡ *Drepanopeziza populorum* (Desm.) Höhn., Ann. Mycol. 15: 332 (1917).

Drepanopeziza populi causes a leaf disease of poplar that is widespread in temperate regions (Callan 1998, Farr & Rossman 2017). Spiers & Hopcroft (1998) considered *Marssonina populi*, based on *Leptothyrium populi*, to be the asexual morph of *D. populorum*. This fungus was described and illustrated by Pirozynski (1974c) using the asexual morph name *Marssonina populi*. As neither *Gloeosporium* nor *Marssonina* is available as a generic name for this species, it is least disruptive to combine the well-used epithet in the appropriate genus *Drepanopeziza* as *D. populi*.

The name *Leptothyrium populi* was published in an exsiccati number that includes a description; the title page of the fascicle carries the date 1834 (Pfister 1985) but Sayre (1969) dated it as 1837 on the basis of reviews. The type specimen of *Trochila populorum* was issued as part of Desmazières' exsiccati on 21 March 1857, according to Pfister (1985). This number includes a description on the label and thus should be regarded as the original description and type specimen. This name was also included in an article published later in March 1858 in Desmazières (1858), which has mistakenly been regarded as the place of publication. A lectotype was designated by Spiers & Hopcroft (1998).

Acknowledgements

We thank curatorial staff at several herbaria for their assistance, specifically Reinhard Berndt (ZT), Robert Lücking (B), Donald Pfister (FH), and Matthias Schultz (HBG). In addition we appreciate the thoughtful reviews of Jeffrey Stone (Oregon State University, Corvallis) and Peter Johnston (Landcare Research, Auckland, New Zealand).

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MYCOTAXON

ISSN (print) 0093-4666 (online) 2154-8889 Mycotaxon, Ltd. ©2017

October–December 2017—Volume 132, pp. 957–969

https://doi.org/10.5248/132.957

Key to the lichen families *Pyrenulaceae* and *Trypetheliaceae* in Vietnam, with eight new records

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Abstract—An identification key is presented for the members of the lichen families *Pyrenulaceae* and *Trypetheliaceae* in Vietnam. Eight pyrenocarpous species (in *Anthracothecium*, *Astrothelium*, *Lithothelium*, and *Pyrenula*) collected from Nam Cat Tien National Park, are new records for Vietnam. Taxonomic characters of the species are given along with ecology, distribution, and illustrations.

Key words—*Bathelium*, *Nigrovothelium*, taxonomy, *Trypethelium*

Introduction

Pyrenocarpous lichens in the tropics belong mainly to the families *Porinaceae*, *Pyrenulaceae*, *Strigulaceae*, and *Trypetheliaceae* and are among the major constituents of epiphytic lichen communities in primary rain forests (Aptroot 2009). Although little remains of Vietnam's primary forests, the protected areas, reserve forests, and national parks still conserve significant stretches of old-growth rain forests, particularly in the southern part of the country. The present inventory is the result of ongoing research conducted in Nam Cat Tien National Park situated in southern Vietnam and provides new records of eight pyrenocarpous lichens in *Trypetheliaceae* and *Pyrenulaceae* for Vietnam. Both families have been the focus of increasing global interest in recent years. Currently, 234 species in 11 genera are accepted in *Pyrenulaceae*, and 418 species in 15 genera in *Trypetheliaceae* (Aptroot 2012, Aptroot & Lücking 2016, Lücking et al. 2016). From Vietnam 24 species of *Pyrenulaceae* have been

recorded: *Anthracothecium macrosporum* (Hepp) Müll. Arg., *A. prasinum* (Eschw.) R.C. Harris; *Pyrenula aggregata* (Fée) Fée, *P. anomala* (Ach.) Vain., *P. aspistea* (Ach.) Ach., *P. balia* (Kremp.) R.C. Harris, *P. breutelii* (Müll. Arg.) Aptroot, *P. brunnea* Fée, *P. duplicans* (Nyl.) Aptroot, *P. fetivica* (Kremp.) Müll. Arg., *P. mamillana* (Ach.) Trevis., *P. massariospora* (Starbäck) R.C. Harris, *P. microcarpa* Müll. Arg., *P. nitidella* (Schaer.) Müll. Arg., *P. nitidula* (Bres.) R.C. Harris, *P. ochraceoflava* (Nyl.) R.C. Harris, *P. parvinuclea* (Meyen & Flot.) Aptroot, *P. pyrenuloides* (Mont.) R.C. Harris, *P. quassiicola* (Fée) Fée, *P. scutata* (Stirt.) Zahlbr., *P. sexlocularis* (Nyl.) Müll. Arg., *P. subglabrata* (Nyl.) Müll. Arg., *P. sublaevigata* (Patw. & Makhija) Upreti, *P. thelemorpha* Tuck.—while 16 species have been recorded in *Trypetheliaceae: Astrothelium aeneum* (Eschw.) Aptroot & Lücking, *A. cinnamomeum* (Eschw.) Müll. Arg., *A. clypeatum* Aptroot & Gueidan, *A. megaspermum* (Mont.) Aptroot & Lücking, *A. nitidiusculum* (Nyl.) Aptroot & Lücking, *A. phlyctaena* (Fée) Aptroot & Lücking [= *Trypethelium ochroleucum* (Eschw.) Nyl.], *A. porosum* (Ach.) Aptroot & Lücking, *A. variolosum* (Ach.) Müll. Arg.; *Bathelium albidoporum* (Makhija & Patw.) R.C. Harris, *B. lineare* (C.W. Dodge) R.C. Harris, *B. porinosporum* Lücking et al.; *Nigrovothelium tropicum* (Ach.) Lücking et al.; *Trypethelium eluteriae* Spreng., *T. epileucodes* Nyl., *T. infraeluteriae* Aptroot & Gueidan, *T. krempelhuberi* Makhija & Patw. (Aptroot & Sparrius 2006, Aptroot 2012, Aptroot et al. 2016, Lücking et al. 2016).

In addition to some previously reported species, we examined some interesting pyrenocarpous lichens that we report here as new Vietnamese records: *Anthracothecium interlatens*, *Astrothelium galligenum*, *A. inspersogalbineum*, *A. subaequans*, *Lithothelium obtectum*, *Pyrenula circumfiniens*, *P. laetior*, and *P. mastophora*. An artificial key to all known species in Vietnam representing *Pyrenulaceae* and *Trypetheliaceae* is also presented.

Materials & methods

The Vietnamese material was collected by Dr. J.-S. Hur and J.J. Woo in December 2015 from the lowland areas in southern Vietnam having warm and humid preserved forests with a sub-oceanic climate. The material was deposited in the lichen herbarium of the Korean Lichen Research Institute, Suncheon, South Korea (KoLRI), and studied in the Lichenology laboratory of CSIR-National Botanical Research Institute, Lucknow, India. The morphological characters were identified and measured using a MSZ-TR dissecting microscope and a Leica DM 500 compound microscope. Standard protocols were followed to analyse chemistry (Orange et al. 2010). Amyloidity (I+ or I–) of internal structures was tested using Lugol's solution. Images were taken using a Zeiss Axiocam ERc5s and A1(AX10) microscope. The key includes some characters that

were not apparent in our specimens but were derived mainly from Upreti (1991, 1998), Aptroot et al. (2008), Aptroot (2012), and Aptroot & Lücking (2016).

Taxonomy

Anthracothecium interlatens (Nyl.) Aptroot, Lichenologist 44: 35, 2012. Pl. 1A

Thallus epi- to endoperidermal, pale green to fawn, corticate, continuous, matt to slightly glossy, reflecting bark texture, delimited by blackish prothallus, 100–120 µm thick; cortex 50–60 µm thick; photobiont trentepohlioid, layer distinct, ≤50 µm thick; medulla not apparent; perithecia semi-immersed to emergent, black, scattered to aggregate with shared ostiole, 0.5–0.7 mm in diam.; perithecial wall complete, carbonized, 45–80 µm thick; ostiole apical, 0.071–0.1 mm in diam; hamathecium hyaline, clear, with unbranched filaments; asci 2-spored, 200–230 × 45–52 µm, I–; ascospores mostly hyaline to grayish at maturity, oblong to slightly curved, muriform, 100–132 × 32–42 µm, I–.

Chemistry—No lichen substances present.

Distribution & ecology—Pantropical (Aptroot 2012). In Vietnam, the species was found growing in association with *Ocellularia* spp. in irregular patches on uneven bark surfaces.

Specimen examined: **VIETNAM. Dong Nai Province: Tan Phu district**, Cat Tien National Park, forest red soil area, 11°24′20″N 107°17′19″E, alt. 256 m, on bark, 17 December 2015, Hur & Woo VN150006 (KoLRI).

Remarks—*Anthracothecium gregale* (C. Knight) Aptroot is morphologically close but produces 6–8-spored asci (Aptroot 2012). Only a small amount of *A. interlatens* was collected in only a small amount from the national park, but the Vietnamese specimen was easily identifiable.

Astrothelium galligenum (Aptroot) Aptroot & Lücking, Lichenologist 48: 861, 2016. Pl. 1B

Thallus epiperidermal, pale greenish gray to greenish gray, smooth, continuous, glossy, delimited by blackish prothallus, ≤180 µm thick; cortex distinct, continuous, 50–60 µm thick; photobiont trentepohlioid, layer distinct, continuous, 40–50 µm thick; medulla white crystalline, reaching ≤70 µm; ascomata immersed to slightly emergent, trypethelioid, scattered, solitary to slightly confluent, 0.2–0.3 mm in diam., pseudostromatic; pseudostromata off-white, irregular in shape; ostiole apical, black, 0.01–0.03 mm in diam.; perithecial wall complete, carbonized, 90–100 µm thick hamathecium hyaline, inspersed with oil droplets, with anastomosing filaments; asci 8-spored, 140–170 × 20–30 µm, I–; ascospores uni- to biseriate, fusiform, hyaline, transversely 7–8-septate with diamond shaped lumina, 40–47 × 10–12 µm, I–.

Chemistry—Thallus and ascomata UV–, hamathecium oil droplets K+ purple; anthraquinone present.

Distribution & ecology—Eastern Palaeotropics (Aptroot & Lücking 2016). This species is apparently rare in the national park, where it was growing in association with *Bathelium mastoideum* and *Sarcographa* spp. on trees with somewhat undulating thick smooth bark.

Specimen examined: **VIETNAM. Dong Nai Province: Tan Phu district**, Nam Cat Tien National Park, in forest red soil area, 11°23′49″N 107°17′38″E, alt. 206 m, on bark, 17 December 2015, Hur & Woo VN150125 (KoLRI).

Remarks—*Astrothelium ubianense* (Vain.) Aptroot & Lücking is similar, but has a clear hamathecium and lacks anthraquinone (Aptroot & Lücking 2016).

Astrothelium inspersogalbineum Aptroot & Weerakoon, Lichenologist 48: 618, 2016. Pl. 1c

Thallus epiperidermal, greenish gray to yellowish green, smooth, continuous, glossy, delimited by blackish prothallus, 100–150 µm thick; cortex distinct, 30–40 µm thick photobiont trentepohlioid, layer distinct, continuous, 50–60 µm thick; medulla endoperidermal; ascomata emergent, trypethelioid, scattered, solitary to slightly aggregate then open by a common ostiole, mostly covered by thallus, 0.6–0.7 mm in diam.; ostiole apical to slightly eccentric, black, 0.08–0.1 mm in diam.; perithecial wall complete, carbonized, 100–150 µm thick laterally, reaching ≤350 µm basally; hamathecium hyaline, inspersed with oil droplets, with anastomosing filaments, placed deep into the ascomata; asci 8-spored, 40–50 × 10–12 µm, I–; ascospores mostly uniseriate, fusiform, hyaline, transversely 3-septate with diamond shaped lumina, 20–22 × 7–9 µm, I–.

Chemistry—Thallus and ascomata UV+ yellow, K+ purple; lichexanthone and anthraquinone present.

Distribution & ecology—This is only the second report of this taxon, originally described from Singapore (Aptroot et al. 2016). In Vietnam, it was growing luxuriantly in association with *Bathelium mastoideum* on thick smooth-barked trees.

Specimen examined: **VIETNAM. Dong Nai Province: Tan Phu district**, Nam Cat Tien National Park, in forest red soil area, 11°23′36″N 107°17′56″E, alt. 181 m, on bark, 17 December 2015, Hur & Woo VN150126 (KoLRI).

Remarks—This species is close to *Astrothelium macrocarpum* (Fée) Aptroot & Lücking, which differs in its clear hymenium and pseudostromatic ascomata (Aptroot 2012). Our Vietnamese *A. inspersogalbineum* specimen,

with a K+ purplish thallus, differs slightly from the K– holotype (Aptroot & Lücking 2016).

Astrothelium subaequans Müll. Arg., Bot. Jahrb. Syst. 6: 383, 1885. Pl. 1D

Thallus epiperidermal, olive green, bullate, uneven, hard, continuous, dull to ± glossy, delimited by blackish prothallus, 200–300 µm thick, photobiont trentepohlioid, layer distinct, continuous, 40–50 µm thick; medulla white, crystalline, 200–350 µm thick; ascomata astrothelioid, scattered, solitary to aggregate and pseudostromatic, covered by thallus, surrounded by yellow-orange pigments, 0.7–1 mm in diam.; ostiole slightly eccentric, black, 0.5–0.1 mm in diam.; perithecial wall complete, carbonized, laterally 100–130 µm thick and basally reaching ≤600 µm, separated from the thallus by a slit; hamathecium hyaline, clear with anastomosing filaments, placed deep into the ascomata; asci 8-spored, 145–155 × 40–47 µm, I–; ascospores biseriate, oval, hyaline, muriform, 60–65 × 18–21 µm, I–.

Chemistry—Thallus UV–, ascomata UV+ reddish, pigment K+ purple; anthraquinone present.

Distribution & ecology—Previously known from the Neotropics (Aptroot 2016). In Vietnam, the species was growing richly in large patches on trees with thick and hard bark.

Specimen examined: **VIETNAM. Dong Nai Province: Tan Phu district**, Nam Cat Tien National Park, in forest red soil area, 11°24′20″N 107°17′19″E, alt. 256 m, on bark, 17 December 2015, Hur & Woo VN150054 (KoLRI).

Remarks—This species is close to *Astrothelium praetervisum* (Müll. Arg.) Aptroot & Lücking, which differs in producing pseudostromatic ascomata (Aptroot & Lücking 2016). Our Vietnamese *A. subaequans* specimen is characterized by distinctly muriform ascospores that differ slightly from the submuriform ascospores described by Aptroot & Lücking (2016).

Lithothelium obtectum (Müll. Arg.) Aptroot, Biblioth. Lichenol. 44: 62, 1991. Pl. 1E

Thallus epiperidermal, grayish green, corticate, continuous, dull to slightly glossy, delimited by black prothallus, ≤100 µm thick; cortex 20–30 µm thick; photobiont trentepohlioid, layer 40–50 µm thick; medulla not apparent; perithecia emergent, black, irregularly in shape to shortly elongate, numerous, solitary to aggregated in groups of 2–3 joint together with fused ostiole, 0.2–0.7 mm long; ostiole eccentric to laterally placed, 0.05–0.1 mm in diam.; perithecial wall complete, carbonized, 90–100 µm thick; hamathecium hyaline, clear, with unbranched filaments; asci 8-spored, 60–90 × 8–12 µm,

I–; ascospores uniseriate, fusiform, hyaline, transversely 3-septate, 10–15 × 3–4 µm, I–.

Chemistry—No lichen substances present.

Distribution & ecology—Pantropical (Aptroot et al. 2008). In Vietnam, the species was collected from hard, rather rough-barked trees, where it was growing luxuriantly with crustose lichen taxa, probably *Graphidaceae*.

Specimens examined: **VIETNAM. Dong Nai Province: Tan Phu district**, Nam Cat Tien National Park, near Crocodile lake, 11°27′25″N 107°21′4″E, alt. 156 m, on bark, 19 December 2015, Hur & Woo VN150400, VN150402 (KoLRI).

Remarks—The examined specimen differs from the type of *Sagedia obtecta* Müll. Arg. (especially in thallus formation and number of fused ascomata). It is possible that the ecorticate thin thallus and solitary ascomata describing the type are features taken from a damaged specimen with an eroded thallus. *Lithothelium decumbens* (Müll. Arg.) Aptroot is close to *L. obtectum* but differs in producing brown ascospores (Aptroot 2012).

Pyrenula circumfiniens Vain.,
Ann. Acad. Sci. Fenn., Ser. A, 6(7): 195, 1915. Pl. 1F

Thallus epiperidermal, olive green to dark green, corticate, continuous, glossy, delimited by black prothallus, 100–150 µm thick; cortex 40–60 µm thick; photobiont trentepohlioid, layer 50–70 µm thick; medulla not apparent; perithecia semi-immersed, black, numerous, solitary to sometimes aggregated in 2–3 groups, 0.3–0.5 mm in diam.; ostiole eccentric to laterally placed in different directions, 0.01–0.2 mm in diam.; perithecial wall complete, carbonized, 90–100 µm thick; hamathecium hyaline, clear, with unbranched filaments; asci 8-spored, 60–90 × 8–12 µm, I–; ascospores uniseriate, fusiform, gray brown, transversely 3-septate, terminal lumina directly against the exospores wall, 13–18 × 4–6 µm, I–.

Chemistry—No lichen substances present.

Distribution & ecology—Pantropical (Aptroot 2012). In Vietnam, *Pyrenula circumfiniens* was flourishing well around trees having wide girth. The species was spread largely in irregular patches and intermingled marginally with other pyrenocarpous lichens.

Specimen examined: **VIETNAM. Dong Nai Province: Tan Phu district**, Nam Cat Tien National Park, near rock stream, 11°26′39″N 107°24′22″E, alt. 160 m on bark, 18 December 2015, Hur & Woo VN150250 (KoLRI).

Remarks—The ascospore sizes in our sample are somewhat close to those in *Pyrenula elliptica* Müll. Arg., which is distinguished by its slightly larger (15–18 × 6–8 µm) ascospores and distribution restricted to the Neotropics (Aptroot 2012).

Pyrenula laetior Müll. Arg., Bot. Jahrb. Syst. 6: 413, 1885. Pl. 1G

Thallus epi- to endoperidermal, brownish green to reddish brown, corticate, continuous, ± dull, delimited by black prothallus, ≤100 µm thick; cortex 20–25 µm thick; photobiont trentepohlioid, layer ≤30 µm thick; medulla indistinct, mostly endoperidermal; perithecia semi-emergent, black, numerous, simple to aggregate, 0.2–0.3 mm in diam.; ostiole apical, 0.05–0.07 mm in diam.; perithecial wall complete, carbonized, 50–80 µm thick; hamathecium hyaline, inspersed with oil droplets, with unbranched filaments; asci 8-spored, 40–60 × 8–6 µm, I–; ascospores uniseriate, fusiform, gray brown, transversely 3-septate, terminal lumina separated from the exospore wall by endospore thickening,13–15 × 4–6 µm, I–.

Chemistry—No lichen substances present.

Distribution & ecology—Previously known from the Neotropics (Aptroot 2012). In Vietnam, the species is found on thin papery bark flaking away from tree trunks.

Specimen examined: **VIETNAM. Dong Nai Province: Tan Phu district**, Cat Tien National Park, forest red soil area, 11°24′23″N 107°17′40″E, alt. 288 m, on bark, 17 December 2015, Hur & Woo VN150083 (KoLRI).

Remarks—*Pyrenula subglabrata*, previously reported from Vietnam, is morphologically similar to *P. laetior* but can be distinguished by its longer (18–20 µm) ascospores (Aptroot 2012). Our material, which produces very short (≤15 µm) ascospores fits well within the range of the new world *Pyrenula laetior*.

Pyrenula mastophora (Nyl.) Müll. Arg., Flora 66: 426, 1883. Pl. 1H

Thallus epiperidermal, green to grayish green, corticate, continuous, smooth, delimited by a black prothallus, ≤150 µm thick; cortex 35–40 µm thick; photobiont trentepohlioid, layer ≤45 µm thick; medulla indistinct; perithecia semi-immersed to semi-emergent, initially covered by thallus, black, numerous, scattered, 0.5–0.8 mm in diam.; ostiole apical, indistinct to 0.5 mm in diam.; perithecial wall complete, carbonized, 60–90 µm thick; hamathecium hyaline, clear, with unbranched filaments; asci 8-spored, 150–160 × 20–26 µm, I–; ascospores mostly uniseriate, fusiform, gray brown, transversely 3-septate, terminal lumina separated from the exospore wall by endospore thickening, 28–32 × 11–13 µm, I–.

Chemistry—No lichen substances present.

Distribution & ecology—Pantropical (Aptroot 2012). The Vietnamese specimen broadly colonized on trees with thick smooth bark.

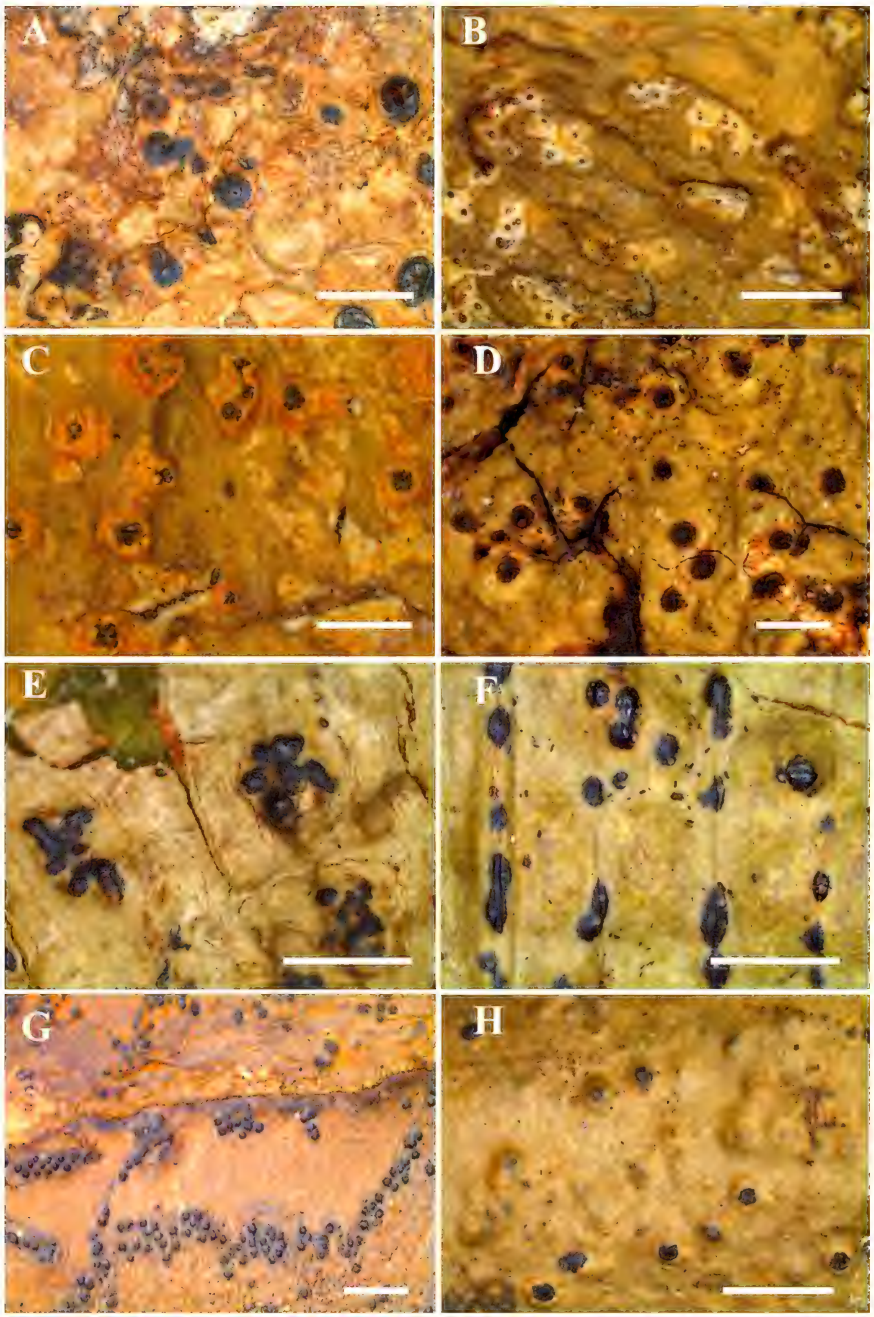
Specimen examined: **VIETNAM. Dong Nai Province: Tan Phu district**, Nam Cat Tien National Park, near rock stream, 11°26′35″N 107°24′19″E, alt. 150 m on bark, 18 December 2015, Hur & Woo VN150216 (KoLRI).

Remarks—*Pyrenula quassiicola* is similar but is distinguished from *P. mastophora* by its partly immersed perithecia and thallus producing pseudocyphellae (Aptroot 2012).

Key to species in *Pyrenulaceae and Trypetheliaceae* recorded from Vietnam

1. Ascospores hyaline 2
1. Ascospores pigmented 21
2. Ascospores transversely septate 3
2. Ascospores muriform 19
3. Ascospore lumina rectangular to oval at maturity 4
3. Ascospore lumina diamond-shaped 10
4. Ascospores 3-septate, 10–15 × 3–4 µm; ostiole lateral ..... ***Lithothelium obtectum***
4. Ascospores >3-septate; ostiole apical 5
5. Ascomata solitary to irregularly confluent 6
5. Ascomata pseudostromatic 7
6. Ostiole usually white pruinose; ascospores transversely 5–7-septate, 25–32 × 6–9 µm ..... ***Bathelium albidoporum***
6. Ostiole non-pruinose; ascospores transversely 3–5-septate, 20–30 × 6–7 µm ..... ***Bathelium porinosporum***
7. Pseudostromata lacking anthraquinone (all white with small dark ostiole spots; ascospores 5–13-septate, 30–60 × 5–13 µm) ..... ***Trypethelium epileucodes***
7. Pseudostromata with anthraquinone 8
8. Ostiolar area broad, disc shaped with margins producing black papillae arranged in circular shapes (ascospores 13–15-septate, 59–72 × 13–15 µm) .... ***Trypethelium krempelhuberi***
8. Ostiolar area narrow, visible as small dots 9
9. Pseudostromata immersed to erumpent; ascospores 7–9-septate, 37–42 × 9–11 µm ..... ***Trypethelium infraeluteriae***
9. Pseudostromata prominent to sessile; ascospores 9–13-septate, 37–52 × 8–11 µm ..... ***Trypethelium eluteriae***

Plate. 1. Specimens of pyrenocarpous lichens from Vietnam. A. *Anthracothecium interlatens* (KoLRI VN150006); B. *Astrothelium galligenum* (KoLRI VN150125); C. *A. inspersogalbineum* (KoLRI VN150126); D. *A. subaequans* (KoLRI VN150054); E. *Lithothelium obtectum* (KoLRI VN150400); F. *Pyrenula circumfiniens* (KoLRI VN150250); G. *P. laetior* (KoLRI VN150083); H. *P. mastophora* (KoLRI VN150216). Scale bars: 1 mm.


A
B
C
D
E
F
G
H

10. Ascospores 7–8-septate (40–47 × 10–12 μm) ..... ***Astrothelium galligenum***
10. Ascospores 3-septate 11

11. Hamathecium inspersed with oil droplets 12
11. Hamathecium clear 14

12. Ostiole lateral (ascospores 20–22 × 7–9 μm;
anthraquinone and lichexanthone present) .... ***Astrothelium inspersogalbineum***
12. Ostiole apical 13

13. Ascomata solitary; ascospores 17–27 × 7–10 μm;
anthraquinone and lichexanthone both absent ..... ***Astrothelium clypeatum***
13. Ascomata diffusely pseudostromatic; ascospores 17–27 × 7–10 μm;
anthraquinone present, lichexanthone absent ..... ***Astrothelium porosum***

14. Ostiole apical 15
14. Ostiole lateral 18

15. Ascomata distinctly pseudostromatic (ascospores 15–27 × 7–10 μm;
anthraquinone absent, lichexanthone present) ..... ***Astrothelium phlyctaena***
15. Ascomata solitary to irregularly confluent or diffusely pseudostromatic 16

16. Ascomata solitary to diffusely pseudostromatic; anthraquinone present,
lichexanthone absent (ascospores 20–27 × 7–10 μm) ..... ***Astrothelium aeneum***
16. Ascomata solitary to irregularly confluent or crowded; anthraquinone and
lichexanthone both absent 17

17. Ascomata sessile, fully exposed, barrel-shaped, black;
ascospores 20–25 × 7–10 μm ..... ***Nigrovothelium tropicum***
17. Ascomata erumpent with broad white area surrounding the ostiole
or entirely white; ascospores 15–27 × 7–10 μm ..... ***Astrothelium nitidiusculum***

18. Ascospores 20–26 × 7–9 μm;
lichexanthone present, anthraquinone absent ..... ***Astrothelium variolosum***
18. Ascospores 23–30 × 6–10 μm;
lichexanthone absent, anthraquinone present ..... ***Astrothelium cinnamomeum***

19. Ascospore lumina rectangular to oval at maturity
(100–120 × 13–20 μm) ..... ***Bathelium lineare***
19. Ascospore lumina diamond-shaped 20

20. Ostiole apical; hamathecium inspersed with oil droplets; ascospores mostly 4/ascus,
140–220 × 30–75 μm; anthraquinone absent ..... ***Astrothelium megaspermum***
20. Ostiole lateral; hamathecium clear; ascospores 8/ascus,
60–65 × 18–21 μm; anthraquinone present ..... ***Astrothelium subaequans***

21. Ascospores transversely septate 22
21. Ascospores muriform 39

22. Ostiole lateral, pointing in different directions
(ascospores 3-septate, 13–18 × 4–6 μm) ..... ***Pyrenula circumfiniens***
22. Ostiole apical 23

23. Ascospores 4–7-septate, with orange oil at maturity (24–32 × 10–15 µm; thallus pseudocyphellate) ..... ***Pyrenula sexlocularis***
23. Ascospores 3-septate 24
24. Ascomata mostly aggregate with fused walls but with separate ostioles (pseudostromatic) (ascospores 15–20 × 6–8 µm) ..... ***Pyrenula anomala***
24. Ascomata mostly single 25
25. Thallus ecorticate (whitish; ascospores 17–25 × 7–11 µm) .. ***Pyrenula microcarpa***
25. Thallus corticate 26
26. Terminal lumina directly against the exospore 27
26. Terminal lumina separated from exospore by thickened endospore wall. 28
27. Hamathecium inspersed with oil droplets; ascospores 16–24 × 8–13 µm ..... ***Pyrenula fetivica***
27. Hamathecium clear; ascospores 17–22 × 9–12 µm ..... ***Pyrenula nitidula***
28. Hamathecium inspersed with oil droplets 29
28. Hamathecium clear 32
29. Ascomata ≤0.7 mm in diam. 30
29. Ascomata>0.7 mm in diam. 31
30. Ascospores 13–15 × 4–6 µm ..... ***Pyrenula laetior***
30. Ascospores 16–22 × 8–10 µm ..... ***Pyrenula subglabrata***
31. Ascospores 15–20 × 4.5–7.5 µm ..... ***Pyrenula mamillana***
31. Ascospores 18–25 × 6–9 µm ..... ***Pyrenula massariospora***
32. Ascospores mostly >25 µm long 33
32. Ascospores mostly <25 µm long 34
33. Thallus pseudocyphellate; ascomata immersed ..... ***Pyrenula quassiicola***
33. Thallus lacking pseudocyphellae; ascomata emergent ..... ***Pyrenula mastophora***
34. Ascospores mostly 21–25 µm long (ascomata <0.5 mm diam.) ... ***Pyrenula nitidella***
34. Ascospores <21 µm long 35
35. Ascospores mostly <15 µm long 36
35. Ascospores mostly>15 µm long 37
36. Ascospores 4–6 µm wide ..... ***Pyrenula aspistea***
36. Ascospores 6–8 µm wide ..... ***Pyrenula brunnea***
37. Ascomata 0.4–0.7 mm in diam. ..... ***Pyrenula aggregata***
37. Ascomata>0.7 mm in diam. 38
38. Lumina round, ascospores 18–22 × 6–9 µm ..... ***Pyrenula scutata***
38. Lumina angular, ascospores 19–22 × 7–8 µm ..... ***Pyrenula balia***
39. Ascomata mostly aggregated with shared ostiole (astrothelioid) (ascospores 100–132 × 32–42 µm) ..... ***Anthracothecium interlatens***
39. Ascomata mostly single 40

40. Ascospores <100 µm long 41
40. Ascospores>100 µm long 47
41. Thallus and ascomata with orange-yellow anthraquinone (ascospores 12–25 × 8–13 µm) ..... ***Pyrenula ochraceoflava***
41. Thallus and ascomata lacking anthraquinone 42
42. Ascospores 12–23 × 8–12 µm ..... ***Pyrenula parvinuclea***
42. Ascospores>25 µm long 43
43. Mature ascospores filled with orange oil (38–50 × 15–20 µm) ....***Pyrenula breutelii***
43. Mature ascospores lacking orange oil 44
44. Hamathecium inspersed with oil droplets (ascospores 30–45 µm long) ..... ***Pyrenula sublaevigata***
44. Hamathecium clear 45
45. Ascospores 60–90 × 30–40 µm ..... ***Anthracothecium prasinum***
45. Ascospores <65 µm long 46
46. Ascospores 33–45 × 11–16 µm ..... ***Pyrenula thelemorpha***
46. Ascospores 45–65 × 15–25 µm ..... ***Pyrenula pyrenuloides***
47. Thallus pseudocyphellate; ascospores 2 per ascus, 110–180 × 30–45 µm ..... ***Pyrenula duplicans***
47. Thallus non-pseudocyphellate; ascospores 1–4 per ascus, 120–160 × 30–45 µm ..... ***Anthracothecium macrosporum***

Acknowledgments

This work was supported by a grant from the National Research Foundation of Korea (NRF-2014K1A3A1A09063058) and the Korean National Research Resource Center Program (NRF-2017M3A9B8069471). Santosh Joshi thanks Director, CSIR-NBRI, Lucknow, India, for providing laboratory facilities. The authors are grateful to Dr. André Aptroot (ABL Herbarium, The Netherlands) and Dr. Robert Lücking (Botanischer Garten und Botanisches Museum, Berlin) for their valuable comments on the manuscript.

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MYCOTAXON

ISSN (print) 0093-4666 (online) 2154-8889 Mycotaxon, Ltd. ©2017

October–December 2017—Volume 132, pp. 971–975

https://doi.org/10.5248/132.971

Acumispora delicata sp. nov. from the Brazilian Atlantic Forest

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Abstract—A new species, *Acumispora delicata,* collected on decaying leaves of an unidentified plant, is described and illustrated. The new species is distinguished by narrow ovoid to broad obclavate conidia, which are acuminate toward the rounded or obtuse apex. A key and illustrations of *Acumispora* species are provided.

Key words—asexual fungi, neotropic, taxonomy, systematics

Introduction

The genus *Acumispora* was described by Matsushima (1980) and typified by *Acumispora uniseptata* Matsush. It is characterized by conidiophores that are macronematous or micronematous, unbranched or irregular branched, mostly prostrate, sometimes erect, septate, brown or pale brown, sometimes reduced

to conidiogenous cells that are monoblastic, determinate or polyblastic, after several sympodial extensions, integrated or discrete, denticulate. The conidia are solitary, acrogenous or acropleurogenous, navicular, narrow ovoid, obclavate, acuminate or rostrate toward the apex, very pale brown to brown, with a minute basal frill after the rhexolytic conidial secession.

During a mycological survey of microfungi associated with leaf litter in a Brazilian Atlantic forest, a conspicuous fungus was collected. It is described as a new *Acumispora* species.

Materials & methods

Individual collections were placed in plastic bags, taken to the laboratory, and treated according to Castañeda-Ruiz et al. (2016). Mounts were prepared in polyvinyl alcohol-glycerol (8 g PVA in 100 ml water, plus 5 ml glycerol) and lactofuchsin (0.1 g acid fuchsin, 100 ml 85% lactic acid) following Carmichael (1955) or lactic acid (90%). Measurements were made at a magnification of ×1000 under a Nikon Eclipse Ni-U microscope with bright field optics, and photomicrographs were taken using DIC optics with a Nikon DS-Fi2 camera. The holotype was deposited in the Herbarium of Universidade Federal de Pernambuco, Recife, Brazil (URM).

Taxonomy

Acumispora delicata P.M.O. Costa, Malosso & R.F. Castañeda, **sp. nov.** Figs 1, 2B

Index Fungorum IF 554059

Differs from *Acumispora biseptata* by its smaller, 3-septate conidia.

Type: Brazil, Pernambuco, Igarassú, RPPN Refúgio Ecológico Charles Darwin, 7°48′S 34°57′W, on decaying leaves of an unidentified plant, 12.V.2017, coll. P.M.O. Costa (**Holotype**, URM 90134).

Etymology: Latin, *delicata*, means delicate, elegant, graceful.

Colonies on the natural substrate, epiphyllous, slightly funiculose, scattered granulose, yellowish-brown. Mycelium mostly superficial, composed of septate, unbranched, pale yellowish-brown, smooth-walled hyphae, 1–2 µm diam. Conidiophores micronematous, prostrate, mostly reduced to conidiogenous cells. Conidiogenous cells monoblastic, discrete, determinate, lageniform, abruptly tapered, cylindrical at the conidiogenous loci, pale yellowish-brown to pale brown, 4–8 × 3–3.5 µm. Conidial secession rhexolytic. Conidia solitary, acrogenous, narrow ovoid to broad obclavate, acuminate toward the rounded or obtuse apex, straight, 3-septate, smooth, pale yellowish-brown or pale brown, 15–20 × 3–4 µm, dry.

Notes: Four species have been accepted previously in *Acumispora: A. biseptata* Matsush., *A. phragmospora* Matsush., *A. uniseptata*, and *A. verruculosa* Heredia et al. (Heredia et al. 2007, Matsushima 1980). *Acumispora*

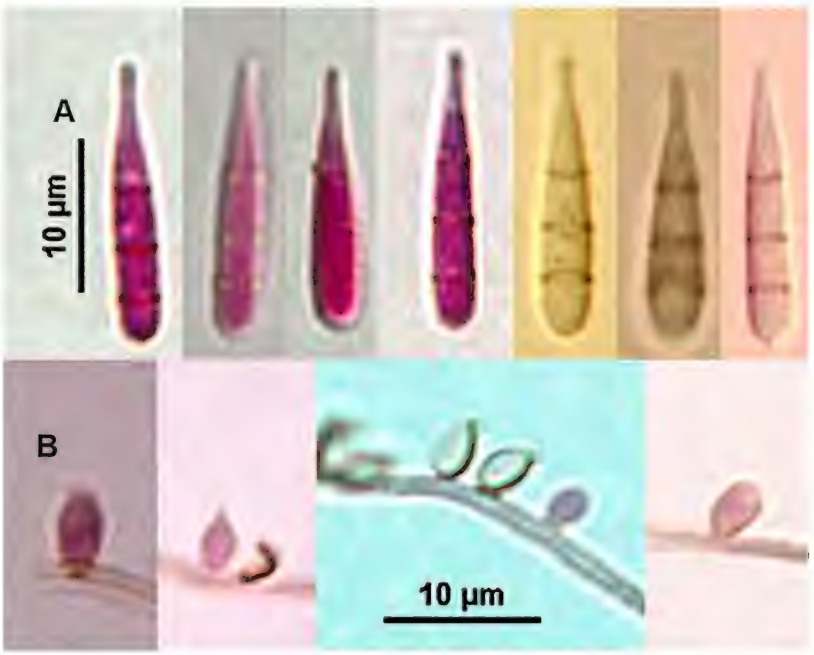

FIG. 1. *Acumispora delicata* (ex holotype, URM 90134). A. Conidia. B. Conidiogenous cells.

delicata resembles *A. biseptata*, which differs by its 2-septate, constricted at the septa, longer (16–25 µm) conidia, with a triangular, elongated, rostrate apical cell. Conidia of the five species are illustrated in FIG. 2.

Key to *Acumispora* species

1. Conidia smooth 2
1. Conidia verruculose (obclavate to slightly ovate, 2-septate, constricted at the septa, 25.4–33.5 × 4.4–5.5 µm) ..... *A. verruculosa*
2. Conidia 1-septate (inequilateral, more or less navicular to slightly obturbinate, with linear-triangular, rostrate apical cell, 23–28 × 5.5–6.5 µm) ... *A. uniseptata*
2. Conidia with more than one septum 3
3. Conidia 2-septate (narrow ovoid with linear-triangular elongated, rostrate apical cell, 16–25 × 4–5 µm) ..... *A. biseptata*
3. Conidia with more than 2-septate 4
4. Conidia 3-septate, narrow ovoid to broad obclavate, acuminate toward the apex, 15–20 × 3–4 µm ..... *A. delicata*
4. Conidia 3–6-septate, cylindrical-fusiform or long navicular, apex acuminate, 20–35 × 4–5 µm ..... *A. phragmospora*

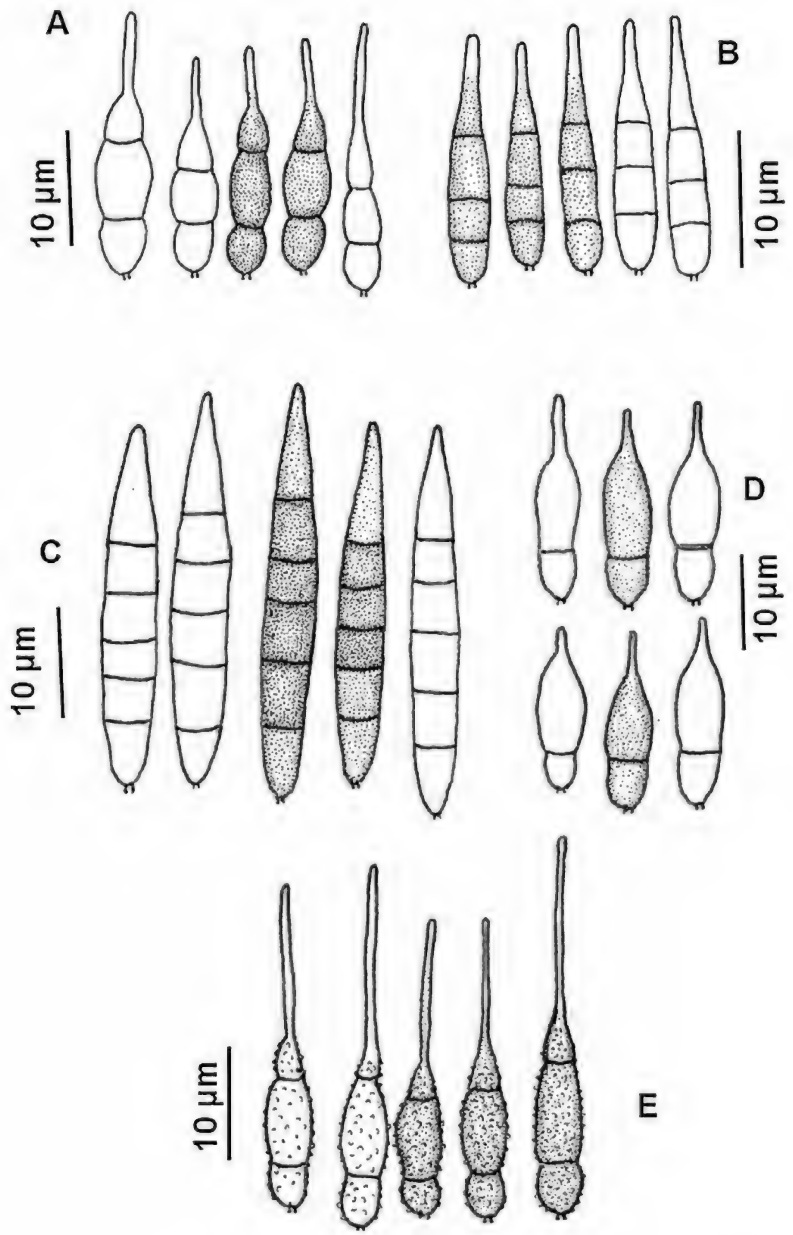

FIG. 2. *Acumispora* spp., conidia: A. *A. biseptata* (Matsushima 1980); B. *A. delicata* (ex holotype, URM 90134); C. *A. phragmospora* (Matsushima 1980); D. *A. uniseptata* (Matsushima 1980); E. *A. verruculosa* (Heredia et al. 2007).

Acknowledgments

The authors express their sincere gratitude to Dr. Xiu-Guo Zhang and Dr. De-Wei Li for their critical review of the manuscript. The authors are grateful to the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) for financial support through Project 88881.062172/2014-01 and the Programa Ciência sem Fronteiras. RFCR is grateful to the Cuban Ministry of Agriculture and Programa de Salud Animal y Vegetal, Project P131LH003033 for facilities. DS is grateful to the Escuela Superior Politécnica del Litoral, ESPOL, (CIBE) for financial support. We acknowledge the facilities provided by Dr. P.M. Kirk and Drs. V. Robert and K. Bensch, through the Index Fungorum and MycoBank websites. Dr. Lorelei Norvell's editorial review and Dr. Shaun Pennycook's nomenclature review are greatly appreciated.

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MYCOTAXON

ISSN (print) 0093-4666 (online) 2154-8889 Mycotaxon, Ltd. ©2017

October–December 2017—Volume 132, pp. 977–983

https://doi.org/10.5248/132.977

Anisogenispora insignissima gen. & sp. nov. from the Brazilian semi-arid region

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Abstract—A new genus and species *Anisogenispora insignissima* is described and illustrated. The fungus, found on decaying fruit of an unidentified dicotyledonous plant, is distinguished by blastic production of globose to broadly pyriform, 1–2-septate, bicolored conidia and a *Thielaviopsis*-like synanamorph with lenticular, doliiform, cylindrical, or vermiform, unicellular or multiseptate, black conidia produced by thallic-arthric disarticulation. All conidiogenous events originate on the same conidiophores.

Key words—asexual fungi, hyphomycetes, taxonomy, tropics

Introduction

The Brazilian semiarid region, located in the northeast of the country, covers approximately 900,000 km^2 and exhibits a high biodiversity (Giulietti et al. 2006). Its different vegetation has favored highly diverse microfungi and the discovery of several new species (e.g., Almeida et al. 2014, Barbosa et al. 2013, Fiuza et al. 2014, Leão-Ferreira et al. 2015, Monteiro et al. 2016, Silva & Gusmão 2013, Silva et al. 2014). During a mycological survey of conidial fungi from the semi-arid region in Serra do Ramalho, Bahia State, an interesting fungus was collected that showed remarkable differences from all previously described hyphomycetes (Seifert et al. 2011); it is described here as a new genus and species.

Materials & method

Samples of decaying plant materials collected in Serra do Ramalho, Bahia State were placed in plastic bags for transport to the laboratory where they were treated according to Castañeda-Ruiz et al. (2016) and placed in humid chambers. Several attempts to obtain these species in pure culture were unsuccessful after transferring conidia with a flamed needle to malt extract agar [2% (w/v) malt extract and corn meal agar, mixed 1:1 with carrot extract] incubated at 25 °C. Mounts were prepared in PVL (polyvinyl alcohol, lactic acid) and measurements were made at 1000× magnification. Microphotographs were obtained with an Olympus BX51 microscope equipped with bright field and Nomarski interference optics. The type specimen is deposited in the Herbarium of Universidade Estadual de Feira de Santana, Bahia, Brazil (HUEFS).

Taxonomy

Anisogenispora S.M. Leão, Gusmão & R.F. Castañeda, **gen. nov.**

Index Fungorum IF 552545

Differs from *Repetophragma* by its monoblastic and polyblastic conidiogenous cells with percurrent and sympodial extensions and by its chlamydospore-like synanamorph with thallic-arthric disarticulation originating near the conidiophore apex.

Type Species: *Anisogenispora insignissima* S.M. Leão et al.

Etymology: *aniso-* (Greek) meaning unequal, uneven, or dissimilar + *-geni-* (Latin) meaning born or produced and referring to the blastic and thallic modes of conidial ontogeny + *-spora* (Latin) referring to the conidia.

Colonies on the natural substrate effuse, brown. Conidiophores macronematous, mononematous. Conidiogenous cells monoblastic and polyblastic, integrated, indeterminate, with enteroblastic percurrent extension, sometimes polyblastic with sympodial extension; conidial secession schizolytic. Conidia solitary, brown, euseptate, smooth, dry. Synanamorph *Thielaviopsis*-like, terminal, dark brown, euseptate, originating near the apex of the conidiophores, forming conidia by thallic-arthric disarticulation; conidial secession schizolytic; conidia unicellular or multicellular, dark brown or black, smooth.

Anisogenispora insignissima S.M. Leão, Gusmão & R.F. Castañeda, **sp. nov.** Figs 1–3

Index Fungorum IF 552546

Differs from *Repetophragma biseptatum* and *R. quadriloculare* by its conidiogenous cells with percurrent and sympodial extension and by its *Thielaviopsis*-like synanamorph originating from the conidiophores and conidia.

Type: Brazil, Bahia State, Coribe, Serra do Ramalho, 43°47′W 13°32′S, alt. 450–600 m, on fallen decaying fruit of an unidentified dicotyledonous plant, 16.III.2008, coll. S.M. Leão-Ferreira (**Holotype**, HUEFS 210449).

Etymology: *insignissima* (Latin) meaning very remarkable, referring to pleomorphic conidia produced on the same conidiophores.

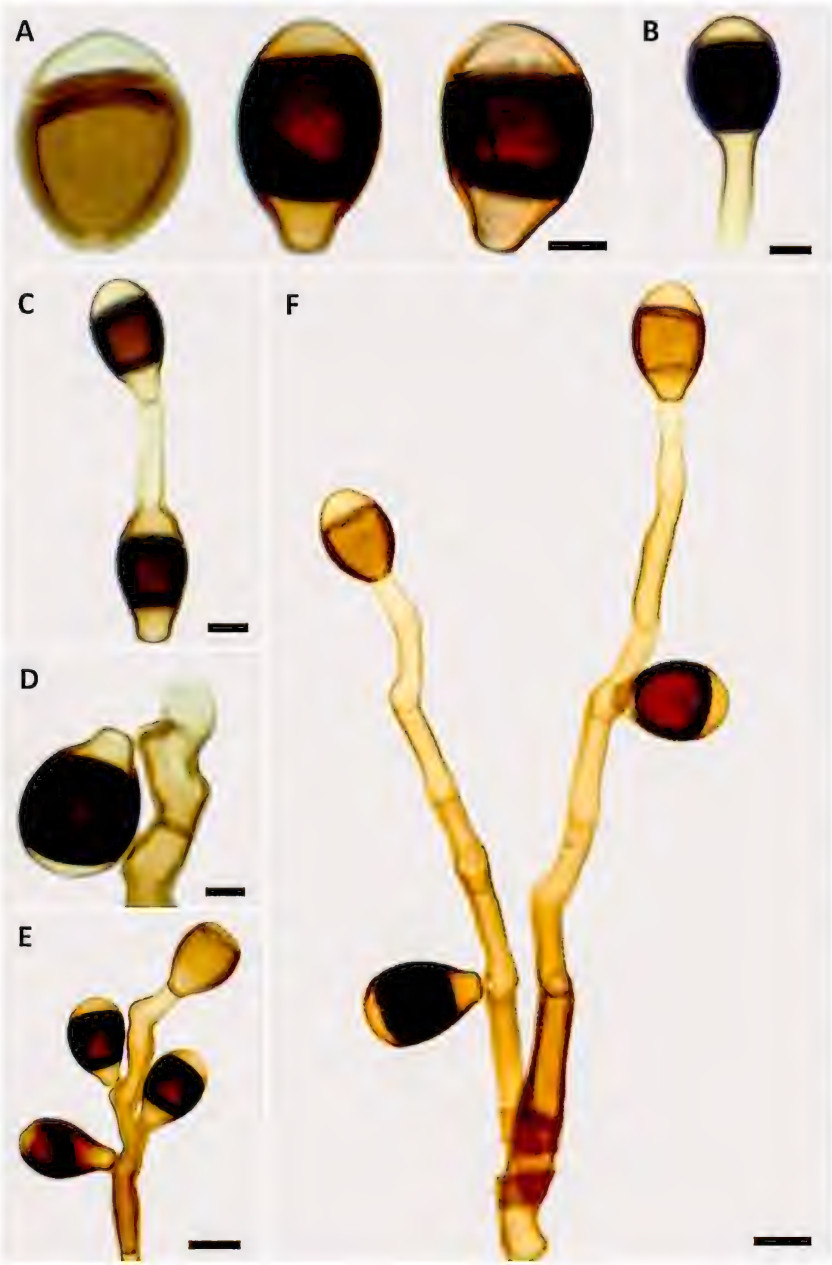

Fig. 1. *Anisogenispora insignissima* (holotype, HUEFS 210449). A–C. Conidia. D, E. Conidiogenous cells and conidia. F. Conidiophores, conidiogenous cells, and conidia. Scale bars = 10 µm.

Colonies on the natural substrate effuse, hairy-granulose, dark brown to black. Mycelium superficial and immersed, composed of septate, branched, smooth, 2–4 µm diam, brown to pale brown hyphae. Conidiophores macronematous, mononematous, erect, flexuous, straight or geniculate, unbranched, rarely branched, 2–7-septate, brown, or alternately and irregularly versicolored brown, pale brown or dark brown, 90–300 × 7.5–10 µm, with 4–12 enteroblastic percurrent extensions, smooth. Conidiogenous cells monoblastic, sometimes polyblastic, cylindrical, integrated, indeterminate, terminal becoming intercalary with frequent and numerous enteroblastic percurrent extensions and sometimes with holoblastic, sympodial extension after a percurrent extension, 8–20 × 3 µm, smooth, pale brown to brown. Conidiogenous loci flat. Conidia solitary, acrogenous or acropleurogenous, broad pyriform, subglobose, somewhat turbinate to obovoid, (1–)2-septate, bicolored, basal and apical cells pale brown, middle cell dark brown or black, smooth, 17.5–30 × 12.5–20 µm. Synanamorph *Thielaviopsis*-like, single, doliiform, cylindrical, vermiform, or long fusiform to navicular, mostly terminal, 2–16-euseptate, slightly constricted at the septa, 50–200 × 15–28 µm, very dark brown or black, originated near or at the apex of the conidiophores and conidia, forming thallic-arthric conidia by disarticulation at the septa; conidial secession schizolytic; conidia lenticular, doliiform, cylindrical, 0–12-septate, dark brown or black, 8–120 × 13–28 µm, smooth, dry.

Note: *Anisogenispora insignissima* resembles *Repetophragma biseptatum* (M.B. Ellis) Subram. and *R. quadriloculare* (Matsush.) R.F. Castañeda et al. in conidial shape and the enteroblastic percurrent extension of the conidiogenous cells, but *R. biseptatum* and *R. quadriloculare* do not have sympodial extension of the conidiogenous cells (Castañeda-Ruiz et al. 2011), nor do they produce a *Thielaviopsis*-like synanamorph with thallic-arthric conidial ontogeny such as is present on the conidiophores in *A. insignissima*. Hyphae in some species of *Chalara* (Corda) Rabenh. develop *Thielaviopsis*-like synanamorphs (similar to the *A. insignissima* synanamorph), but *Chalara* exhibits an enterogenous conidial ontogeny, considered as phialidic (Nag Raj & Kendrick 1976). The *Thielaviopsis*-like synanamorph produced in *Arthrotaeniolella* L.B. Conc. et al.

Fig. 2. *Anisogenispora insignissima* (holotype, HUEFS 210449). A. Young growing conidium from *Thielaviopsis*-like synanamorph after its germination. B. Conidiogenous cells, conidia, and *Thielaviopsis*-like synanamorph. C,D. Thallic-arthric conidia of *Thielaviopsis*-like synanamorph. E, F. Conidiogenous cells, conidia, and thallic-arthric conidia of *Thielaviopsis*-like synanamorph. Scale bars = 10 µm.

A
B
C
D
E
F

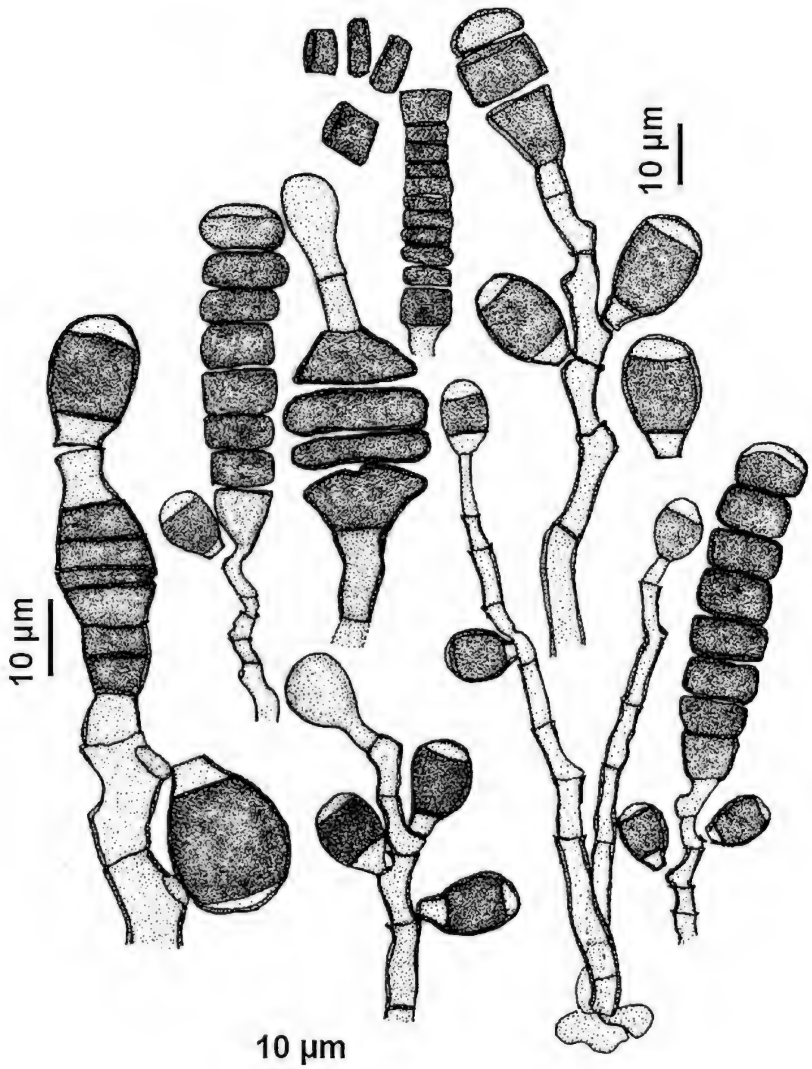

Fig. 3. *Anisogenispora insignissima* (holotype, HUEFS 210449). Conidiophores, conidiogenous cells, and conidia; and thallic-arthric conidia of *Thielaviopsis*-like anamorph.

is also somewhat similar to that of *A. insignissima*, but *Arthrotaeniolella* species are freshwater fungi with thallic-arthric disarticulation of the conidiophore branches (Monteiro et al. 2017).

Acknowledgments

We are indebted to Dr. Xiu Guo Zhang and Dr. De-Wei Li for their critical reviews. The authors thank to the National Council for Scientific and Technological Development (CNPq; Proc. 451991/2016-8). The first author is grateful to Coordination for the Improvement of Higher Education Personnel (CAPES) through project Nº 071/2012. RFCR is grateful to OSDE, Grupo Agrícola from the Cuban Ministry of Agriculture and Programa de Salud Animal y Vegetal, project P131LH003033. Dr. Lorelei L. Norvell's editorial review and Dr. Shaun Pennycook's nomenclature review are greatly appreciated.

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MYCOTAXON

ISSN (print) 0093-4666 (online) 2154-8889 Mycotaxon, Ltd. © 2017

October–December 2017—Volume 132, pp. 985–986

https://doi.org/10.5248/132.985

Regional annotated mycobiotas new to the Mycotaxon website

Abstract—Mycotaxon is pleased to announce two new species distribution lists to our 'web-list' page covering diversity of wood-inhabiting aphyllophoraceous basidiomycetes on the island of Cyprus (by Loizides) and saprobic asexual microfungi from the tropical cloud forest of Veracruz, México (by Arias, Heredia & Castañeda-Ruiz). This brings to 127 the number of free access mycobiotas now available on the Mycotaxon website: http://www.mycotaxon.com/resources/weblists.html

Europe

Cyprus

Michael Loizides. Diversity of wood-inhabiting aphyllophoraceous basidiomycetes. 27 p.

Abstract—The diversity of wood-inhabiting aphyllophoraceous basidiomycetes on the island of Cyprus is explored in this paper, following a ten-year inventory between 2007 and 2016. A total of one-hundred-and-eight taxa are reported, fifty-eight of which constitute new records for the country. Twenty-two species occurring on the narrow-endemic golden oak of Cyprus (*Quercus alnifolia*) are documented for the first time on this host. Collections of *Laetiporus sulphureus* sensu lato from *Ceratonia* and *Eucalyptus* are phylogenetically analysed and revealed to belong to a distinct clade likely representing an undescribed species. Among the newly reported taxa, of particular interest are *Amaurodon viridis*, *Asterostroma ochroleucum*, *Byssomerulius hirtellus*, *Crustoderma dryinum*, *Dendrocorticium polygonioides*, *Postia inocybe*, *P. simani*, *Steccherinum ciliolatum*, and *S. oreophilum*, all of which are considered rare and are seldom reported in literature. The aggressive conifer pathogens *Heterobasidion annosum* and *Porodaedalea pini* are also rare and do not appear to have a significant impact on the island's pine-dominated forests. *Fuscoporia torulosa*, on the other hand, is commonly encountered on sclerophyllous vegetation and should be closely monitored. Previous aphyllophoraceous records from the island are critically discussed and re-evaluated, with old and new data compiled in the form of an annotated checklist, to include notes on the substrate, fruiting season, altitude, and estimated abundance.

North America

Mexico

Rosa María Arias, Gabriela Heredia & Rafael F. Castañeda-Ruiz. Checklist of saprobic asexual microfungi from the tropical montane cloud forest of Veracruz, México. 48 p.

Abstract— A checklist comprising 355 species and 190 genera of asexual microfungi associated with plant debris collected in different localities of the tropical montane cloud forest of Veracruz, Mexico, is presented based on literature and fresh specimens. Annotations (lists of studied material and locations) are accompanied by illustrations of 31 species. A total 101 taxa are recorded for the Mexican mycobiota for the first time.

MYCOTAXON

ISSN (print) 0093-4666 (online) 2154-8889 Mycotaxon, Ltd. © 2017

October–December 2017—Volume 132, pp. 987–1001

https://doi.org/10.5248/132.987

Book reviews and notices*

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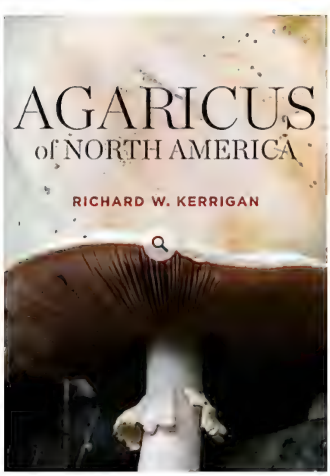
Abstract—Books reviewed include: *Basidiomycetes—Agaricus* of North America (Kerrigan 2016), *Hebeloma* (Fr.) P. Kumm. (Beker et al. 2016); *Lichens*—Lichens of Mexico (Herrera-Campos et al. 2016).

Basidiomycetes

***Agaricus* of North America.** By Richard W. Kerrigan. 2016. Memoirs of the New York Botanical Garden, Vol. 114. NYBG Press, Bronx NY 10458-5126, USA. 592 p. ~385 color plates & figures, hardback. ISSN 0077-8931; ISBN 978-0-89327-536-5. Price (excl. postage): $127.99. www.nybgpress.org



'*praeclaresquamosus*' is chewy
But the name here turns out to be hooey,
And those who like poison
Will now find their joys in
Agaricus buckmacadooi.

If you take an *Agaricus* census,
The naming will batter your senses,
Some mushrooms that pose as
'*praeclaresquamosus*'
Should really be *deardorffensis.*

The above limerick, dashed off today by British Columbian Ian Gibson (our Pacific Northwest Key Council database expert), captures the west coast's response to Rick Kerrigan's new masterpiece. A trained agaricologist,

* Book reviews or books for consideration for coverage in this column should be sent to the *Editor-in-Chief* <editor@mycotaxon.com> 6720 NW Skyline, Portland OR 97229 USA.

I nonetheless still embarrass myself hemming and hawing over a pristine *Agaricus* presented for field identification. Confidently identifying *Inocybe, Phaeocollybia, Chrysomphalina, Galerina,* and many small or 'valueless' mushrooms, I am flummoxed by the genus that gave agaricology its name. Somewhat defeated by identifications that are misapplications of European concepts, most North American field agaricologists slavishly follow Arora (1986) who—recognizing an *Agaricus* identification crisis when he saw one—cheerfully placed 'group' after species names to give the uncertain identifier a bit of wiggle room. But I digress.

Agaricus of North America is a sturdy hefty tome with stiff hard covers designed to stand up to frequent use. Owners are nonetheless advised to prepare the volume by splaying it firmly flat in sections to prime it for heavy use on lab benches.

Presentation is thorough and comprehensive. The table of contents and acknowledgments precede introductory chapters covering *Agaricus* in the (1) world and (2) commerce; history & nomenclature; literature; "To study and identify *Agaricus*" (a materials & methods section to read and re-read); formats & conventions; edibility caveats; phylogenetic analysis; sequences representing *Agaricus* sections (+ subsections & unnamed major lineages); and typifications of 10 previously published taxa.

These introductory chapters provoke. In "Why this book? Why now?" Kerrigan does not share his 45 years of *Agaricus* field experience in a field guide because "I believe that this presentation uniquely bridges a gap between the typical specialist literature and the typical field guide in a way that will interest many readers." He further notes—

> "What I have attempted to produce is a monographic technical resource that is authoritative, while remaining generally accessible, and is comprehensive to the extent that our existing knowledge allows. ... Agaricus is a difficult, subtle, phenotypically plastic genus with many, many rare and seemingly cryptic species, and North America is a big and diverse continent. ... The present volume ... is just a start, a down payment on what we as stewards of the commons deserve: an exhaustively comprehensive, absolutely authoritative summary of Agaricus in North America.... The process is far from completed."

The author ends his opening chapter with the challenge—"See if you can discover what I've missed."

In "*Agaricus* erected, disused, emended, and conserved" Rick observes—

> "As [Linnaeus] employed the name, *Agaricus* corresponded to the gilled mushrooms. Consequently, for more than a century, most new mushrooms were named as an *Agaricus,* creating a huge list of names for a diverse

> range of species (now mostly reassigned to many segregated genera). This copious nomenclatural residue is just one more cumbersome obstacle, virtually unique to *Agaricus,* impeding the simple use of correct names, thus affecting comprehension and communication."

The 33-page chapter on how to approach the genus clearly explains why so many of the collections studied are Kerrigan's own and how to avoid making collections that are destined to reside only in herbaria—uncharacterized, unattended, and decidedly unloved. The helpful five pages devoted to the objective of *Agaricus* study ["I have applied the names that in my opinion are MOST PROBABLY correct"] precede discussions on characters (macro-/microscopic, eco-/geological, biochemical, molecular, cultural), all summarized in a brief paragraph on p. 49.

Next follow the all-important keys and taxonomic treatments. The titles explain what the keys are designed to do and not do: [i] "Dichotomous key for the placement of agaricoid and secotioid specimens of *Agaricus* subg. *Agaricus* in North America to sections or groups" and "[ii] Quasi-synoptic key for the placement of specimens of *A.* subg. *Agaricus* in North America to sections or groups." The author shares his frustration in crafting keys: "...natural groups in *Agaricus*...are somewhat heterogeneous morphologically and sometimes biochemically, and frustrate attempts to produce elegant dichotomous keys, especially when emphasizing field characters." Hence the synoptic key serves as "the preferred framework for a holistic assessment of attributes and affinities. Once a section or group is selected, one or more subsidiary dichotomous keys for the individual sections follow as each section is introduced...." One complaint may be raised at using only the rDNA ITS region to support new phylogenetic sections, and readers are warned to expect several taxonomic shifts after future multigene sequence analyses are employed.

The formal taxonomic section covers 190 taxa (some represented only by RWK collection numbers) and proposes 34 new names. Descriptions are ordered based on formal section (*Bivelares, Chitonioides, Xanthodermatei, Sanguinolenti, Nigrobrunnescentes, Agaricus, Spissicaules, Subrutilescentes, Rarolentes, Minores, Arvenses*) (further divided into subsections) or the informal 'floridianus', 'longuloid/gryophragmioid', and 'martineziensis' lineages.

A typical section (e.g., *A.* sect. *Bivelares*) begins with a standard nomenclator (but containing only selected synonyms) followed by AFFINITIES, CHARACTERS, the inevitably valuable REMARKS, and KEY to species. This may or may not precede SUBSECTIONS (with their own CHARACTERS, REMARKS, and KEY). Each section/subsection includes an illustration, a graph comparing spore sizes, and a phylotree.

One to two illustrations accompany each 1–4-page species treatment: most are photos—some in situ, most 'morgue' shots of fresh material (so useful to taxonomists but too often snubbed by those hoping to see mushrooms in natural habitats), and several of herbarium exsiccati—with a few drawings or paintings. For reasons obvious to those who know how few *Agaricus* features are diagnostic under high power, there are precious few micrographs.

Species sections include nomenclator, AFFINITIES; technical DESCRIPTION; CHEMISTRY; HABIT, HABITAT, DISTRIBUTION; an always insightful DISCUSSION; and EDIBILITY. [Edibility for *Agaricus bisporus* is noted as: "This mushroom is a prized edible, the most commonly cultivated mushroom in the world, the basis of a multi-billion-dollar industry. Cultivation is not difficult—if you know how."] The amount of new information (based on a lifetime of personal observation) presented here is awe-inspiring.

And yet, there are big swaths of North America that are only superficially studied (the southern and southeastern states), while Mexico merits only a brief mention in the literature section. Most material in the book was collected in California, Pennsylvania, Colorado, and New Mexico. Focused on one continent as it is, the current volume presents keys and descriptions to cover only species confirmed by the author as occurring there.

Since the 1970s, North American agaricologists have confronted far too many misapplied names and a somewhat tumultuous "nomenclatural inconsistency" in the continent's monographs and field guides. As a test, I consulted the 55 names listed in the PNW Key Council provisional key to Pacific Northwest *Agaricus* species (Chariton 1997) to evaluate names accepted by Kerrigan against those still used by most North American field taxonomists. First eliminated were 18 provisional names from an unpublished master's thesis (Isaacs 1963); based on Oregon and Washington specimens, these were never formally proposed and thus (with one exception) missing from Kerrigan's index. After removing synonyms and names with no modern concept and adding nine newly named taxa, the PNW list tallied 39 Kerrigan-accepted *Agaricus* names. That list will grow once the PNW Key Council further mines the volume to identify which additional species inhabit British Columbia, Idaho, western Montana & Alberta, Washington, and Oregon.

The verses at the beginning encapsulate the problems faced by all North American would-be *Agaricus* identifiers. In 1972, I identified one forest mushroom as *Agaricus meleagris,* which was 'corrected' in 1974 to *A. placomyces.* In the early 80s, Oregon Mycological Society members learned that the CORRECT west coast name was *A. praeclaresquamosus* (Kerrigan 1986), only to find thereafter that it also would not serve:

> "The *Agaricus meleagris-placomyces-praeclaresquamosus* complex continues to puzzle, although Rick Kerrigan and colleagues seem to have successfully teased out the western North American cluster. After years of my spelling *A. praeclaresquamosus* Freeman slowly for fellow field mycologists, we now recognize the complex (in the Pacific Northwest at least) as *Agaricus moelleri* Wasser" (Norvell 2016).

But wait! Now *A. deardorffensis* (which has sent people to the hospital in British Columbia) and *A. buckmacadooi* (honoring Washington's own PNW Key Councilor Buck McAdoo) replace the first four errant names (Kerrigan et al. 2005, Norvell 2017). Fortunately *Agaricus* of North America elucidates the misapplied and confused European and North American concepts; those perplexed by this complex are well advised to read and commit to memory pp. 141–143, even while being aware that that the *'deardorffensis'* ITS rDNA (sequenced originally from that mushroom brought into the Vancouver Emergency Room) differs in only ONE base pair from the Tibetan species, *A. tibetensis.*

The dry humor permeating this scientific treatise on all things *Agaricus* will reassure readers who want entertainment with their erudition. I was particularly charmed by a note on the newly minted *Agaricus julius* Kerrigan (p. 394): "Misapplied Names: It has been called "the Prince" (*A. augustus*) in common usage in Colorado; perhaps now it will become the Emperor formerly known as Prince." Such wit is rarely encountered in nomenclators.

The volume concludes with biographies and *Agaricus* species of Kerrigan's North American predecessors (Charles H. Peck, William A. Murrill, Alexander H. Smith, Bill F. Isaacs, Alice E. Freeman), literature cited, lists of critically examined types and vouchers studied and/or sequenced and accepted, nomenclatural citations for the covered taxa, and a 5-page index inexplicably entitled 'Index to scientific names now (or formerly) assigned to *Agaricaceae,* with prior homonyms'[perplexing in that a comprehensive list from 1753 onwards might rival the current volume in length]. On the back of the page containing Rick's biography and photo is printed a 6-in/16-cm ruler, an incitement to all readers to go outside and get busy.

Together with the European *Agaricus* tomes (Parra 2008, 2013) and the ongoing work in Asia (e.g., Zhao et al. 2011), the genus is rapidly losing many of its secrets. We note that the work by Parra (whom Kerrigan warmly credits in his acknowledgments) is quite different in scope and execution than that by Kerrigan. Not so surprising, as Europe has a much longer and more thorough mycological tradition with many more active people in the field.

Kerrigan's solution to life's *Agaricus* problems has been a long time coming but does not disappoint. While taxonomic riddles remain (giving Rick more to do in his off time), many Gordian knots have been sliced. Although we still take refuge in Arora's 'groups', they are becoming smaller and more approachable. Misery does love company, so perhaps most comforting of all is that this North American *Agaricus* expert lets us know that he finds his genus even more difficult than the rest of us do.

Arora D. 1986. Mushrooms demystified. (2nd ed.). Ten Speed Press, Berkeley. 959 p.

Chariton LR. 1997 (reformatted by Ian Gibson April 2003). Trial field key to the species of *Agaricus* in the Pacific Northwest. Pacific Northwest Key Council. < http://www.svims.ca/council/Agari2.htm>

Isaacs BF. 1963. A survey of *Agaricus in* Washington, Oregon, and California. M.S. thesis, University of Washington, Seattle. [unpublished]

Kerrigan RW. 1986. The *Agaricales* (gilled fungi) of California. 6. *Agaricaceae.* Mad River Press, Eureka/ 62 p. + figs.

Kerrigan RW, Callac P, Guinberteau J, Challen MP, Parra LA. 2005. *Agaricus* section *Xanthodermatei:* a phylogenetic reconstruction with commentary on taxa. Mycologia 97: 1292–1315. http://dx.doi.org/10.1139/b97-058

Norvell L. 2016(1992). The regular column: That *nudum* is a *nuda?* ResearchGate author revision of Mushroom, The Journal. Winter 1991–92, 10(1): 15–17. <www.researchgate.net/publication/313159493>.

Norvell L. 2017(1988). The herbarium and how it breeds. ResearchGate author revision of Mushroom, The Journal. Summer 1986, 4(3): 6–9. <www.researchgate.net/publication/310674716>.

Parra Sánchez LA. 2008. *Agaricus* L. *Allopsalliota* Nauta & Bas. Tribu *Agaricaceae* S. Imai Parte I. Fungi Europaei 1. Edizioni Candusso.

Parra Sánchez LA. 2013. *Agaricus* L. *Allopsalliota* Nauta & Bas. Parte II. Fungi Europaei 1A. Edizioni Candusso.

Zhao RL, Karunarathna S, Raspé O, Parra LA, Guinberteau J, Moinard M, De Kesel A, Barroso G, Courtecuisse R, Hyde KD, Guelly AK, Desjardin DE, Callac P. 2011. Major clades in tropical *Agaricus*. Fungal Diversity 51: 279–296. http://dx.doi.org/10.1007/s13225-011-0136-7

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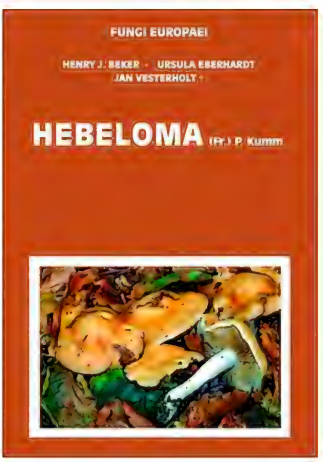
Hebeloma (Fr.) P. Kumm. By H.J. Beker, U. Eberhardt & J. Vesterholt†, 2016. Fungi Europaei 14. Candusso Edizioni s.a.s., <http://eidizionicandusso.it> ISBN 978-88-96059-42-5. 1232 pp, 2654 photos, 200 drawings. 2.8 kilos. Price 86.00 Euros.



Hebeloma is one of those genera in which species recognition has been difficult, which has resulted in a wealth of literature where authors all interpreted names differently and often brought more confusion than clarification. For Europe, there is now an excellent book that brings together a mass of knowledge and data and gives clear reasons for the species that are presented.

What sets this book apart from other taxonomic treatments is the care given to explanations on the decisions made and the different sets of characters that played a role in these decisions (biological data concerning monokaryon mating, morphological data, and molecular DNA data). In some cases morphology tipped the scale to recognize several species; in others the DNA data indicated the existence of differences. It should be noted that a combination of molecular markers was used for species delimitation and that more variable gene regions than the universally used barcode ITS region were sequenced and phylogenetically analysed.

The mating data were provided by earlier research (Aanen & Kuyper 1999) on the *Hebeloma crustuliniforme* group; the first author contributed most microscopic observations, whereas the second author brought into the mix her molecular-phylogenetic skills. Background articles on several sections had been published previously (e.g. Eberhardt et al. 2013, 2015).

The set-up of the book is comparable to others in the series. The introduction describes the different chapters and sets the tone. Those chapters cover the history of the genus, morphology and ontogeny, materials and methods, infrageneric classification, keys to sections (in different languages), six chapters treating the species in the various sections, followed by an extensive overview of ecology and habitat, a list of published names from Europe and north Africa, bibliography, and finally iconography (more than 500 pages!).

Most important is the chapter called "Our approach"—the materials and methods part. This is required reading for every taxonomist, and student in taxonomy. The care with which the research was conducted is exemplary.

Another chapter of enormous importance for taxonomists in and outside Europe is the list of names that have been published but are not included as current and valid names in the description chapters. These names come with annotations of the authors, who studied as many type collections as possible. The almost 100 pages this list comprises indicates the wealth of information here (all original diagnoses are given and, if necessary, translated into English).

All 84 species descriptions have been generated in the same way from the data in the first author's database. This means that they are standardized and follow the same order.

The keys have also been generated from the database, which means that human inflation of characters in the keys is absent.

Illustrations in the description chapters are limited to phylogenetic trees per section or subsection, phenology histograms and distribution maps, and line drawings of type specimen's microscopic characters, but the colour photographs of microscopic and macroscopic characters in chapter 17 add a wealth of information.

Species recognition still will not be easy in this genus, as the differences between species can be quite subtle, sometimes only in one morphological character that needs careful observation, and sometimes there is overlap in morphological characters among species. This is partly due to the fact that the authors sought for and found DNA regions that are more variable than ITS.

But remember, this book provides thorough arguments for or against the decisions made.

It is sad that the third author, Jan Vesterholt, did not live to see the end product of this work (Jan died in 2011). The book is dedicated to his memory; Jan brought his knowledge of the northern European species to this project (Vesterholt 2005).

This book is not the final word on the genus *Hebeloma*—far from it. The authors are now focusing on the North American taxa, and I am looking forward to this next installment. I am very curious to see how many species the two continents have in common, and whether human introductions might have played a role in these patterns.

My appreciation and admiration for the authors in tackling this difficult but important ectomycorrhizal genus hopefully shine through this review.

Aanen D, Kuyper TW, 1999. Intercompatibility tests in the *Hebeloma crustuliniforme* complex in northwestern Europe. Mycologia 91: 783–795.

Eberhardt U, Beker HJ, Vesterholt J, Dukik K, Walther G, Vila J, Brime SF. 2013. European species of *Hebeloma* section *Theobromina*. Fungal Diversity 58: 103–126. https://doi.org/10.1007/213225-12-0188-3

Eberhardt U, Beker HJ, Vesterholt J. 2015. Decrypting the *Hebeloma crustuliniforme* complex: European species of *Hebeloma* section *Denudata* subsection *Denudata* (*Agaricales*). Persoonia 35: 101–147. https://doi.org/10.3767/003158515X687704

Vesterholt J. 2005. The genus *Hebeloma*. Fungi of Northern Europe vol. 3. Svampetryk, Denmark.

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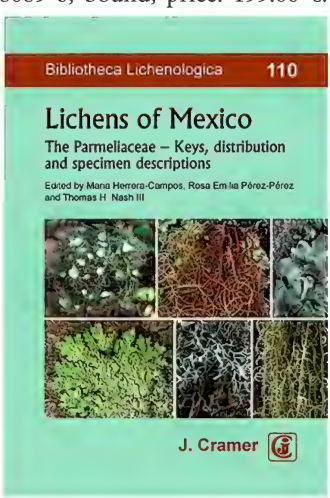
Lichens

***Lichens* of Mexico**. The *Parmeliaceae* - Keys, distribution and specimen descriptions. Maria Herrera-Campos, Rosa Emilia Pérez-Pérez & Thomas H. Nash III (eds.). 2016. Bibliotheca Lichenologica, Vol. 110; vi+723 p., 17 figs., 14x22cm. English. ISBN 978-3-443-58089-6, bound, price: 199.00 €. <www.borntraeger-cramer.de/9783443580896>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Lichens of Mexico
The Parmeliaceae – Keys, distribution and specimen descriptions
Edited by Maria Herrera-Campos, Rosa Emilia Pérez-Pérez and Thomas H. Nash III
J. Cramer

Lichens of Mexico—The *Parmeliaceae* is a valuable resource that will soon be consulted even outside of its intended region. The fact that 20% of the world's *Parmeliaceae* (including the vast majority known from North America) occur in Mexico make this volume helpful in keying out lichens outside of the country, particularly in adjacent Central America, Caribbean, and United States. Its use of the recent realignment of species into phylogenetically supported groups and genera is a particular benefit.

Thick, dense, but compact, the book is held easily in one hand. Its sturdy hardcover appears rain- and incidental spillage-proof, and its firmly bound pages of 'permanent paper conforming to ISO 9706-1994" do not crackle when splayed to prepare for heavy use. The text is crisp and legible, although the spacing is a bit tight for my aging eyes and the margins are far too narrow, forcing one's eye to jump occasionally from one long line to another—all trade offs needed to keep the book affordable and under 800 pages long. This

economy of space has the unfortunate result that even when opened firmly, text on inside margins tends to trail off into the crease. The semi-glossy photos are sharp and clear but amazingly few: As its title clearly indicates, the volume focuses on keys and descriptions. Nonetheless, readers who do read the text should be able to check most of their determinations easily against the excellent photos in Brodo et al. (2001).

Three introductory chapters set the framework for the 450 species to follow. The first, covering Mexico's geology, topography, vegetation, and diversity, provides four maps, two colored to distinguish the different climates and biomes. The country's 2 million km^2 surface area and varied landscape, climate, and ecosystems accommodate ~12% of the world's species. Herrera-Campos et al. note that it has been historically difficult to classify Mexico's biological landscape due the convergence of the Holarctic and Neotropical realms in the Tropic of Cancer, leading to the recognition of (if not agreement on) 10–32 vegetation types within the five biomes.

The second chapter—Phylogenetic structure of metacommunities in Mexican *Parmeliaceae*—presents the first lichen community phylogenetic analysis for Mexico based on the *Parmeliaceae*. Lücking et al. note that the relatively young community phylogenetics field tries to characterize the phylogenetic structure of ecological communities, thereby 'providing insights into evolutionary process' based on the theory 'that closely related species do not usually co-occur in the same community.' The few fungal and micro-organismal studies published before 2006 make these 29 pages the first to apply community phylogenetics to lichens. The 12½-page table shows the presence/absence of the 450 species in Mexico's five major biomes—tropical humid forest, humid mountain forest, temperate forest, seasonally dry forest, and dry shrubland. Species richness and phylogenetic diversity is highest in the temperate forest and lowest in the humid mountain and tropical humid forests, supporting the temperate forest as a center of diversity for Mexican *Parmeliaceae* while less diverse and more clade-specific composition of the seasonally dry forest and dry shrubland favor lineages of the parmotremoid/xanthopermelioid clade and *Oropogon*.

The third introductory chapter presents a molecular-based synopsis of generic classification of *Parmeliaceae:* since 2000, the 'increased availability of DNA sequence data has led to a second revolution of generic delimitations in *Parmeliaceae* based on molecular phylogenetic studies addressing the circumscription of genera.' Crespo et al. briefly evaluate currently accepted

genera, recapitulating recent changes in their circumscription and dividing the family into 7 phylogenetic groups:

Alectorioid—Circumscriptions of *Alectoria, Bryoria,* and *Pseudephebe* remain relatively unchanged. The 2009 separation of *Gowardia* from *Alectoria* is not currently supported, while *Nodobryoria,* segregated previously from *Bryoria,* appears not closely related to *Bryoria.*

Cetrarioid—*Cetraria, Kaernefeltia, Melanelia, Tuckermanella, Tuckermannopsis** [sic], *Vulpicida* represent a usually well-supported monophyletic clade, although current circumscriptions are needed in some instances. "Genetic distances among many currently accepted genera are remarkably low.... Thus at least some of the genera should most likely be merged." In this chapter Crespo & Barrano propose the new *Kaernefeltia iberica* comb. nov. for extralimital Spanish specimens previously referred to *K. merrillii,* a North American endemic.

Hypogymnioid—The first sentence reads: "this group consists of four foliose genera", but only three are named (probably because the authors counted *Cavernula,* whose species were transferred to *Hypogymnia* in 2011). *Brodoa* [not found in Mexico] and *Pseudevernia* are the other two hypogymnioid genera cited here.

Letharioid—Segregation of *Letharia* (found in Mexico) and *Lethariella* awaits further research.

Parmelioid—This largest group accommodates over 1800 accepted species. Of the 21 accepted genera, 5 (*Bulbothrix, Parmelia, Parmelinella,*

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*Nomenclatural note: Although the genus is misspelled '*Tuckermannopsis*' consistently throughout the volume, according to Art. 60.1 of the International code of nomenclature for algae, fungi, and plants (McNeill & al. 2012), the name honoring Edward Tuckerman should be corrected to *Tuckermanopsis,* as originally spelled for the type species *Tuckermanopsis ciliaris* (Ach.) Gyel. and as displayed on Index Fungorum <http://www.indexfungorum.org> and MycoBank <www.mycobank.org>. MycoBank lists '*Tuckermannopsis*' as an orthographic variant.

Thus far I have been unable to determine just exactly when the name acquired the extra 'n' but suspect it might have been introduced by Hale, who transferred 13 species to the genus in the 5th lichen checklist by Egan (1987). Although a Google search tends to turn up more *Tuckermannopsis* hits, the spelling used almost uniformly in the North American books on my library shelves (e.g., Hale & Cole 1988, Brodo et al. 2001 McCune & Geiser 2009), there are quite a few papers (e.g., Harris & Lendemer 2005; Randlane & Saag 2006 + many more European texts) that spell the name as proposed by the Byelorussian Gyelnik in 1933. Note also that when Esslinger (2006) carved the segregate genus, *Tuckermanella* Essl. from *Tuckermanopsis,* he correctly spelled his new genus with only one 'n'.

Parmotremopsis, Pseudoparmelia) are currently polyphyletic, in a state of flux, or lack molecular data; three (*Canoparmelia, Hypotrachyna, Xanthoparmelia*) were recently trimmed for monophyly, and three (*Melanelixia, Melanohalea, Remotrachyna*) are recent segregates. The remaining 10 well-supported monophyletic genera include *Cetrelia, Flavoparmelia, Montanelia, Myelochroa, Parmelina, Parmeliopsis, Parmotrema, Phacopsis, Punctelia,* and *Relicina.*

Protoparmelioid—confined to the polyphyletic *Protoparmelia.*

Usneoid—limited to one genus (*Usnea*) with 350 species and the most highly diverse in tropical areas. *Usnea* now includes previous segregates (e.g., *Dolichousnea, Eumitria, Neuropogon*) phylogenetically nested within it.

Genera with uncertain affinities—*Anzia,* characterised by multispored asci with small curved ascospores and a spongiostratum, is centered in eastern Asia. *Imshaugia* is distinguished by *Parmeliopsis*-like species with emergent laminal/marginal pycnidia and bacilliform/bifusiform conidia. *Menegazzia,* diagnosed by a perforated upper thallus surface, occurs primarily in the southern hemisphere. The morphological segregation of *Nodobryoria* from *Bryoria* is molecularly supported. *Oropogon* a fruticose lichen of the Neotropics with a currently unresolved phylogeny.

A key to the identification of genera representing *Parmeliaceae* in Mexico concludes the introduction.

A formidable array of *Parmeliaceae* experts have written chapters for this volume, with Editors Herrera-Campos (5), Pérez-Pérez (9), and Nash (24) and authors R.S. Egan (5), T.L. Esslinger (10), J.A. Elix (4) each contributing to more than two chapters while J.W. Bjerke, A. Crespo, P.K. Divakar, S.D. Leavitt, James Lendemer, Robert Lücking, H.T. Lumbsch, Bruce McCune, I.KK. Tronstad, J.L. Vilmaseñor, and A. Zambrano Garcia each contributed to at least one.

Thirty-nine generic chapters covering 450 species comprise the bulk (and the goal) of The *Parmeliaceae.* The note added in proof at the bottom of the section's title page hints at editorial headaches suffered over collating over 40 papers, with many undoubtedly arriving only shortly before press time:

> "Herein Dr. Egan proposes treating *everniastrum subplanum* Sipman as a synonym of *Parmotrema paramoreliense* whereas the former species was treated as *Hypotrachyna subplanum* in the *Hypotrachyna* treatment as proposed by Divakar et al. (2013a). The correct placement must await molecular investigations of all relevant material."

Genera are presented in alphabetical order and entitled with the genus name + in Mexico (except for "*Menegazzia* in Mexico and the Caribbean islands"). The chapters range in length from one page (*Cetraria, Phacopsis*) to 103 pages (*Hypotrachyna, Parmotrema*), depending on the number of species. Formatting is consistent: Title and author information are followed by abstract, short genus characterization, and species key (for genera with more than one species covered). Each species treatment begins with the taxonomic heading and nomenclator followed by morphological description, chemical composition, distribution data, and important notes and concludes with a list (often extensive) of specimens examined. Alphabetical presentation —a necessity in such a large volume with no index—and running titles enable rapid location of a particular genus. Eight species new to science are proposed in the *Alectoria* (2), *Hypotrachyna* (1), *Parmotrema* (2), *Pseudevernia* (2), and *Tuckermanella* (1) chapters.

There are a few deviations, perhaps the most startling being that only the species key, taxonomic headings, illustration references, and distributional data appear are provided for *Canoparmelia;* I regret the absence of the rest of the material but suspect that the fact this chapter was written by two already overcommitted editors, Pérez-Pérez & Nash, may have something to do with the decision to withhold the morphological and chemical features [referenced in the abstract as "Descriptions were provided previously"] and final discussions for the 13 species. Still, it will be a bit of a hassle for some readers to find the correct 'previous' paper for the missing information.

I also greatly mourn the lack of a concluding comprehensive species index that would allow easy tracking of new taxonomic realignments, always helpful to those wondering what name a favored species has recently adopted. The information can be ferreted out of the nomenclators, although the reader must know the new name to find out what happened to the old one. This does, however, have the benefit of persuading the user to consult the keys, the whole purpose of the volume!

Finally, given the focus on phylogenetic analysis of biomes, groups, and genera in this volume, I was exasperated by the lack of information regarding which DNA regions were sequenced to generate the phylogenies. A time-consuming scan of the 31-page bibliography proved somewhat helpful, although I found only three titles naming the DNA regions: mitochondrial DNA (Crespo & al. 2001), ITS & ß-tubulin (Crespo & al. 2002), and ribosomal markers + RPB1 (Crespo & al. 2007). Inspection of the multilocus sequences analyzed by Altermann et al. (2014), however,

explains why modern titles do not enumerate all DNA regions used: citing their 15 different loci (even in the abstract) would have needlessly lengthened the paper and the authors cited the needed information in their Materials & methods table. Nonetheless, the nuclear ITS, LSU and mitochondrial SSU rDNA sequences cited in the abstract for "DNA barcoding in the *Hypotrachyna* clade" abstract (Divakar et al. 2015) is information that should have been shared under *Hypotrachyna* in the third chapter. Likewise identifying the DNA barcode used to identify hidden diversity in *Parmelia* sensu stricto (Divakar et al. 2015) as derived from the ITS region should have been noted for that genus.

The rapid change in the complex molecular landscape is perhaps one reason why most authors use vague terms such as 'molecular analyses', 'DNA sequence based', or 'phylogenetic analyses' in their titles (saving the lengthier specifics for the abstracts). If a second edition is anticipated, a brief list of the DNA regions sequenced used to generate the phylogenetic support and their utility (even if just in table form) would be welcome.

The objections raised above are minor and should in no way discourage anyone from purchasing such a useful book that does precisely what it sets out to do: key and describe 450 lichens representing *Parmeliaceae* from Mexico. As noted above, its use will not (nor should) be restricted to Mexico and the reference will prove a reliable resource for all those who use it. I am very happy to have Lichens of Mexico: The *Parmeliaceae* on my lab library shelves.

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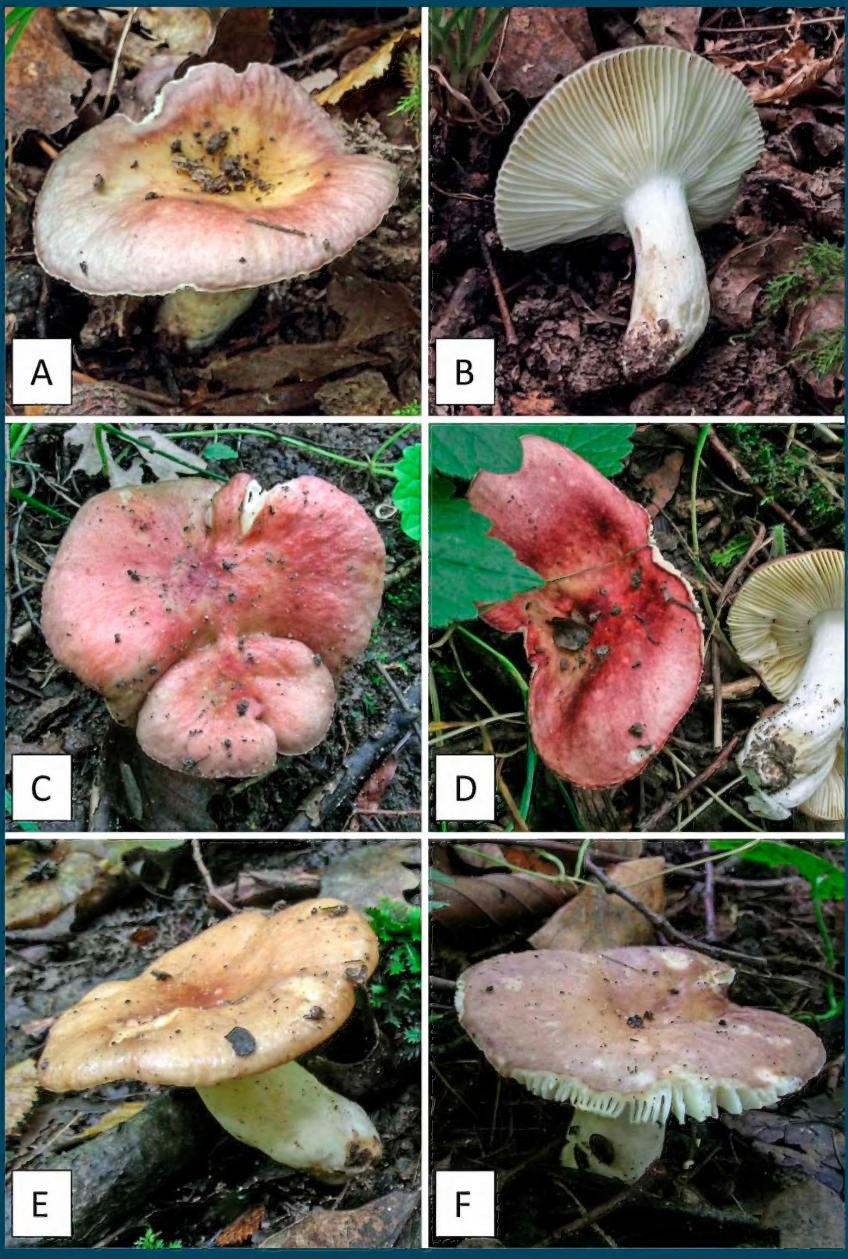

Russula vinosoflavescens sp. nov.
(Trendel, Hampe & Verbeken— Fig. 1, p. 713)